CHAPTER 3
AFFECTED ENVIRONMENT

The Affected Environment Chapter describes the existing condition of the environment within and adjacent to the Ferron Natural Gas Project Area. The information presented for each resource focuses on the issues identified during scoping.

As discussed in Chapters 1 and 2, the Ferron Natural Gas Project Area consists of the North Area, the South Area, and the proposed transmission pipeline corridor (**Plate 2–1**). When a resource discussion applies to the entire area, the term Project Area is used. Discussions unique to certain areas refer to either the North Area, the South Area, or the pipeline corridor.

3.1 GEOLOGY AND MINERALS

3.1.1 Physiography and Topography

The North Area is situated at the northern edge of the San Rafael Swell, a broad, asymmetrical, northeast-trending upwarp within the Colorado Plateau physiographic province (Weiss et al. 1990). This physiographic subprovince is known as the Mancos Shale lowland (Stokes 1986). The landscape of these lowlands is characterized by southerly sloping, gravel-covered pediments, rugged badlands and narrow, flat-bottomed alluvial valleys. The pediments are comprised of fluvial sediments of quaternary origin that rest on shale and siltstone of the Blue Gate Member of the Mancos Shale (Weiss et al. 1990).

The Book Cliffs, steep escarpments capped by resistant sandstones, are located immediately north of the North Area. The Price River valley is west and south of the North Area whereas Coal Creek, a tributary of the Price River, is located to the east.

The surface of the North Area generally slopes to the south from the Book Cliffs to the Price River valley. Slopes are on the order of 5 to 10 percent on the pediment surfaces and 10 to 75 percent on pediment side slopes adjacent to drainages. Elevations range from 5,770 feet in Deadman Creek (SE¼, Section 11, Township (T) 14 South (S), Range (R) 10 East (E) to 7,300 feet at the north edge of the NE¼, Section 24, T13S, R10E, resulting in total relief within the North Area of more than 1,500 feet.

The South Area also is located within the Colorado Plateau physiographic province. It extends from the Castle Valley on the east to the Wasatch Plateau on the west. The Castle Valley is part of the Mancos Shale lowland (Stokes 1986). It is a topographic low between the Wasatch Plateau to the west and the San Rafael Swell to the east (Witkind 1988). The surface of the Castle Valley is characterized by southeast sloping pediments, which consist of quaternary fluvial sediments resting on shale and siltstone of the Bluegate Member of the Mancos Shale (Witkind 1988 and Witkind et al. 1987).

The Wasatch Plateau is high table land comprised of essentially horizontal sandstone beds (Speiker 1931). The eastern margin of the plateau, an abrupt wall of barren cliffs, forms the western boundary of the South Area. To the east of the South Area lies the western flank of the San Rafael Swell. The pattern of landforms within the South Area continues to the north and south of the area.

The surface of the South Area generally slopes to the southeast from the Wasatch Plateau to the Castle Valley. Slopes range from approximately 2 to 10 percent on the pediment surfaces and stream valleys and from about 10 to 100 percent on the pediment and mesa side slopes. Elevations range from 5,670 feet in Rock Creek on the east edge of the NE¼, Section 19, T19S, R8E to 9,090 feet at the center of the western edge of Section 36, T17S, R6E. Therefore, total relief within the South Area is more than 3,400 feet.

3.1.2 Stratigraphy

Stratigraphic and geohydrologic units present within the Project Area are illustrated on **Figure 3–1**. Stratigraphic units exposed at the surface, or relevant to this project are described below. Rock units are described in order from youngest to oldest with the abbreviation for each formation following in parentheses. Formation thicknesses are based on stratigraphic charts 64 (Huntington-Ferron-Emery) and 65 (Helper-Price-Wellington) in the Geologic History of Utah (Hintze 1988).

Alluvium (Qal) (Holocene) is found in the valley bottoms of the major streams (including Cottonwood and Huntington creeks) that cross the South Area. It consists of thin to thick bedded, unconsolidated clay, silt, sand, granules, pebbles and a few cobbles deposited in stream valleys in recent time. Alluvium within the South Area is commonly less than 50 feet thick (Witkind et al. 1987).

Slope Wash (Qsw) (Holocene) forms broad, gently-sloping areas in the Castle Valley. It also includes small unmapped valley fill deposits within the North Area. Slope wash consists of thin to thick bedded, unconsolidated to weakly cemented (locally) clay, silt, sand, and pebbles. Slope wash can reach thicknesses of up to 25 feet in the South Area (Witkind 1988). Slope wash deposits in the North Area are smaller and thinner than those in the South Area.

Alluvial Fan Deposits (Qf) (Holocene) are found at the base of the eastern Wasatch Plateau escarpments. These are unconsolidated to semi-consolidated deposits that consist of moderately well sorted silt, sand, pebbles, and cobbles (Witkind 1988). Within the South Area, alluvial fan deposits are up to 50 feet thick (Witkind et al. 1987).

Pediment Mantle (QTpm) (Holocene to Miocene) is found on the pediment surfaces scattered throughout the North and South areas. It consists of unconsolidated to well-cemented, massive to crudely bedded fluvial sediments (Weiss et al. 1990). The poorly bedded mixture of silt, sand, pebbles, cobbles, and boulders is derived from the adjacent uplands. The surfaces of these deposits are relatively smooth and slope gently away from the Book Cliffs and the Wasatch Plateau. Thicknesses range from 10 to 150 feet.

The Mesaverde Group (Upper Cretaceous), an assemblage of upper Cretaceous rock units, forms cliffs at the western edge of the South Area and immediately north of the North Area. It includes, in descending order, the Price River Formation (Kpr), Castlegate Sandstone (Kc), Blackhawk Formation (Kbh), and Star Point Sandstone (Ksp) (Witkind et al. 1987). It is not present in the North Area.

The Price River Formation is comprised of irregularly bedded sandstone, conglomerate, and conglomeratic sandstone. It ranges in thickness from 600 to 1,000 feet (Hintze 1988) in the South Area.

The Castlegate Sandstone is thin bedded to massive with some conglomerate beds. Its thickness ranges from about 150 to 500 feet in the South Area (Hintze 1988).

MINERALS	GEOHYDROLOGIC UNIT[1,2]	DESCRIPTION	THICKNESS, FT[3]
		Variegated shales with subordinate sandstone, conglomerate and freshwater limestone, thickens to north, slope former.	500–2,500
	MESAVERDE AQUIFER	Gray to white gritty sandstone inter-bedded with subordinate shale and conglomerate, ledge and slope former.	600–1,000
		White to gray, coarse-grained often conglomeratic sandstone, cliff former, weathers to shades of brown.	150–500
COAL CBM		Yellow to gray, fine to medium-grained sandstone, interbedded with subordinate gray and carbonaceous shale, several thick coal seams.	700–1,000
		Yellow-gray, massive cliff-forming sandstone, often in several tongues seperated by Mosuk Shale, thickens westward.	100–1,000
	MANCOS CONFINING UNIT	Yellow to blue-gray sandy shale, slope former, thick in north and central plateau area, thins southward.	300–1,300
COAL?		Yelllow-gray friable sandstone tongue or tongues, cliff former, may contain coal.	50–800
		Pale blue-gray, nodular and irregularly bedded marine mudstone and siltstone with several arenaceous beds, weathers into low rolling hills and badlands, thickens northerly.	1600–3500+
		Friable sandstone tongue or tongues, cliff former. Located within Blue Gate.	70–130
OIL, COAL, CNG, CBM		Alternating yellow-gray sandstone, sandy shale and gray shale with important coal beds of Emery coal field, resistant cliff former.	180–300
OIL		Blue-gray to black sandy marine slope forming mudstone.	200–650
OIL, CNG	DAKOTA AQUIFER	Variable assemblages of yellow-gray sandstone, conglomerate, shale, and coal. Beds lenticular and discontinuous.	0–60
		Varicolored shale underlain by the Buckhorn Conglomerate.	100–800
URANIUM, GYPSUM	MORRISON CONFINING UNIT ?	Variegated-color claystone and mudstone, with a few thin limestone and sandstone lenses.	±570
	MORRISON AQUIFER	Light-gray, thin bedded friable quartzose sandstone with occasional interbeds of conglomerate and mudstone.	±510
	CURTIS-STUMP CONFINIING UNIT	Reddish-brown shaley siltstone with thin, continuous bedding.	120–420
		Light-gray to greenish-gray, glauconitic quartzose sandstone with thin beds of conglomerate.	140–280
	ENTRADA PREUSS AQUIFER	Orangish-brown to light-brown, medium to thick bedded sandstone.	150–950
GYPSUM	CARMEL-TWIN CREEK CONFINING UNIT	Reddish-brown shaley siltstone underlain by light-gray, crystalline limestone.	300–1300
CO_2	NAVAJO-NUGGET AQUIFER	Light brown to light gray, massive crossbedded, quartzose sandstone.	150–320
		Lavender to reddish-brown, crossbedded, quartzose sandstone, well-cemented.	120–250
		Reddish-brown to brown, quartzose sandstone, well-cemented by calcium.	300–400
	CHINLE-MOENKOPI CONFINING UNIT	Reddish-brown to dark brown sandstone and shaley siltstone.	200–300
		Light-gray, crossbedded sandstone with interbeds of conglomeritic sandstone, conglomerate and mudstone.	20–140
CO_2, OIL, URANIUM		Altered, greenish-gray, very fine grained, petroliferous sandstone and shaley siltstone.	420–700
		Yellowish-gray to light brown, crystalline limestone.	50–60
		Greenish-gray to yellowish brown Interbedded quartzose sandstones, shaley siltstones and mudstones.	250–300

AGE	STRATIGRAPHIC UNIT[2] (GROUP)	STRATIGRAPHIC UNIT[2]
CRETACEOUS		LOWER NORTH HORN (CRETACEOUS)
	MESAVERDE GROUP	PRICE RIVER FORMATION
		CASTLEGATE SANDSTONE
		BLACK HAWK FORMATION
		STAR POINT SANDSTONE
	MANCOS SHALE	UPPER BLUE GATE MEMBER
		EMERY SANDSTONE MEMBER
		BLUE GATE MEMBER
		GARLEY CANYON SANDSTONE MEMBER
		FERRON SANDSTONE MEMBER
		TUNUNK SHALE MEMBER
	DAKOTA GROUP	DAKOTA SANDSTONE
		CEDAR MOUNTAIN FORMATION
		BUCKHORN CONGLOMERATE
JURASSIC	MORRISON FORMATION	BRUSHY BASIN MEMBER
		SALT WASH
	SAN RAFAEL GROUP	SUMMERVILLE FORMATION
		CURTIS FORMATION
		ENTRADA SANDSTONE
		CARMEL FORMATION
	GLEN CANYON GROUP	NAVAJO SANDSTONE
TRIASSIC		KAYENTA FORMATION
		WINGATE SANDSTONE
	CHINLE FORMATION	CHURCH ROCK MEMBER
		MOSS BACK MEMBER AND TEMPLE MOUNTAIN MEMBER
	MOENKOPI FORMATION	UPPER PART
		SINBAD LIMESTONE
		LOWER PART

Note: Adapted from BLM, 1997c

1 FROM FREETHEY AND CORDY, 1991.
2 EXCLUDES QUATERNARY AND TERTIARY DEPOSITS.
3 HINTZE, 1988

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Figure 3-1
Stratigraphic Geohydrologic Column

The Blackhawk Formation consists of bedded quartzose sandstones with shaley siltstone, shale, carbonaceous shale, and coal interbeds (BLM 1997c). It ranges in thickness from 700 to 1,000 feet (Hintze 1988) in the South Area.

The Star Point Sandstone is a fine- to medium-grained gradational unit between the Blackhawk Formation and the underlying Mancos Shale. In the South Area, its thickness ranges from 100 to 1,000 feet (Hintze 1988).

The Mancos Shale (Upper Cretaceous) is exposed at the surface over much of the North and South areas. It consists of six members (in descending order): Upper Blue Gate, Emery Sandstone, Blue Gate, Garley Canyon Sandstone, Ferron Sandstone, and Tununk Shale (BLM 1997c, Weiss et al. 1990, Witkind 1988, and Witkind et al. 1987).

The Upper Bluegate (or Masuk) Member (Kmub) is a slope-forming, thin- to medium-bedded shale and shaley siltstone with a few thin interbedded sandstone beds. It ranges in thickness from 300 to 1,300 feet (Hintze 1988).

The Emery Sandstone Member (Kme) consists of upper and lower sandstone units separated by a middle shale unit. The sandstone units are cliff-forming and consist of thin-to medium bedded, very fine grained quartzose sandstone. The middle shale unit consists of thin- and even-bedded shale and shaley siltstone with a few interbedded thin sandstone beds. The Emery Sandstone ranges in thickness from 50 to 800 feet (Hintze 1988) with thickness increasing from east to west.

The Blue Gate Member (Kmbg) (or Lower Blue Gate Member) is a slope-forming, thin- to medium-bedded shale and shaley siltstone with sparse interlayered thin sandstone beds. Thickness ranges from 1,600 to more than 3,500 feet (Hintze 1988).

The Garley Canyon Member (Kmgc) consists of two thin, cliff-forming sandstone beds separated by shale. It occurs within the Blue Gate Member and ranges in thickness from 70 to 150 feet within the North Area (Hintze 1988).

The Ferron Sandstone Member (Kmf) consists of an upper and lower sandstone unit separated by a middle shale unit. Total thickness ranges from 200 to 250 feet on the eastern side of the South Area to 300 feet on the western side (as documented by Texaco). Within the North Area, thickness of the Ferron is about 180 to 200 feet (Bunnell and Hollberg 1991). There are up to 13 coal beds within this member, although most areas average 5 coal layers (Tabet 1995). The individual coal beds average 4 to 9 feet thick with total coal thicknesses of up to 40 feet. The coals and sandstone intervals are the primary production target for the project.

The Tununk Member (Kmt) forms the base of the Mancos Shale. It consists of thin- to medium-bedded shale and shaley siltstone. It ranges in thickness from 200 to 650 feet. Neither the Tununk Member nor older formations below it are exposed at the surface within the Project Area.

The Dakota Group (Cretaceous), Morrison Formation (Jurassic), Summerville Formation (Jurassic), Curtis Formation (Jurassic), Entrada Sandstone (Jurassic), and Carmel Formation (Jurassic) lie below the Mancos Shale. Their combined thickness ranges from about 1,900 to 4,900 feet. These formations lie between the production zone and the Navajo Sandstone, the target formation for project disposal wells. The Carmel Formation, located directly above the Navajo, contains anhydrite which is important for containment of disposal water injected into the Navajo.

The Navajo Sandstone (Jurassic and Triassic) is a thick-bedded to massive, fine-grained quartzose sandstone with a few thin lenticular limestone beds in the upper part. It ranges in thickness from 150 to 300 feet (Hintze 1988).

3.1.3 Structure

Several structural features occur in the vicinity of the Project Area. The San Rafael Swell is a large, elongate, asymmetric anticline that plunges to the northeast. The axis of this anticline is located east of the Project Area. Strata dip as steeply as 80 degrees on the east flank of this anticline while strata on the west flank dip only 5 to 15 degrees (Stokes 1986). The Uinta Basin is an east-west trending, asymmetric syncline which lies northeast of the Project Area (BLM 1997c). The Book Cliffs, an erosional escarpment located immediately north of the North Area, separate the Uinta Basin from the Mancos Shale lowlands. The Wasatch Plateau is an erosional remnant capped by essentially horizontal sedimentary rocks (Stokes 1986). It is located west of the Project Area.

The structure of the North Area is dominated by the regional northward dip of strata from the San Rafael Swell toward the Uinta Basin (Nethercott 1985 and Russon 1992). This northward dip averages 5 degrees in the North Area. There is no indication of faulting in this area.

The South Area lies on the western flank of the San Rafael Swell, resulting in a slight dip of strata to the west (Witkind 1988). This trend is interrupted slightly by two local features, the Huntington Anticline and the Castle Dale Dome, which lie west of Huntington and east of Castle Dale, respectively. These features are located outside the Project Area.

Several faults exist in the South Area. Most are concentrated in the northwest corner where a series of north-south trending, high-angle normal faults are found (Witkind et al. 1987). Within this area, known as the Pleasant Valley fault zone (Doelling 1972), displacements of up to 450 feet have been identified. Within the Pleasant Valley fault zone, 12 major faults exist along with shear zones containing numerous smaller faults (Speiker 1931).

3.1.4 Geologic Hazards

The Project Area lies within seismic risk zone 2 (on a scale of 0 to 3, with 3 being the highest risk) (Algermissen 1969). Seismic risk zones are based on the number and intensity of earthquakes per 100-year period. Moderate damage from earthquakes corresponding to an intensity of 7 (on the Modified Mercalli Intensity Scale, which measures intensities from 1 to 12) is the maximum impact that can be expected within the Project Area. A search of the National Earthquake Information Center database was conducted to identify seismic events that have occurred within a 250-km (155-mile) radius of the geographic center of the Project Area. During the period January 1, 1973 through October 31, 1997, 31 earthquakes of magnitude 4.0 to 5.7 occurred within the 250-km radius. The largest had a magnitude of 5.7 and was centered 140 miles to the east near Rio Blanco, Colorado. A 5.5 magnitude event occurred in 1988 and was centered only 19 miles southeast of the geographic center of (but outside of) the Project Area.

Seismic events have occurred in the area associated with long wall coal mining. These events tend to be small in magnitude, ranging from approximately 2 to 3.5 (Walter et al. 1996).

Mass movements including rockfall, landslides, and slumps are common along the Book Cliffs and Wasatch Plateau escarpments. These events occur at the foot of these escarpments in the northern margin of the North

Area and the western margin of the South Area. Slope stability also is of concern within Mancos Shale lowlands, which are found in the majority of the Project Area. The Mancos is easily eroded where exposed to weathering. It is subject to swelling when wet and prone to slope failure where overlain by younger dense rocks.

A soil gas survey was conducted to determine the presence and concentration of methane along a portion of the Ferron Sandstone Member of the Mancos Shale outcrop (Aubry et al. 1998). The outcrop surveyed is adjacent to the FNG Project South Area. Procedures and equipment used ensure repeatability allowing for future trend analysis. In the FNG Project Area, there are no known gas seeps. There is a substantial caprock (± 2,000 feet of impermeable Mancos Shale) between the surface and the gas-producing zone. Ferron coalbeds pinch out several miles west of the outcrop in this area, and are not exposed at the surface. The survey indicates methane, carbon monoxide, and hydrogen sulfide are not escaping along the Ferron outcrop (Aubry et al. 1998).

H_2S has not been encountered to date during drilling in any of the more than 100 CBM wells drilled in the Price area. However, H_2S has been detected in produced water from some of the CBM wells in small amounts (80 to 90 ppm below the minimum level of 100 ppm at which it is regulated under Onshore Order No. 6). Solution H_2S was also recently encountered in the drilling of a disposal well to a depth of approximately 6,000 feet into the Navajo Formation.

3.1.5 Mineral Resources

3.1.5.1 Oil

Although oil production has not occurred within the Project Area, oil shows have been observed in the Dakota Group and the Kaibab Limestone as well as the Ferron and Tununk members of the Mancos Shale. There are four oil fields near the Project Area, including the Flat Canyon, Joe’s Valley, Grassy Trails, and Indian Creek fields. These fields all involve structural traps. Although future exploration could occur within the Project Area, production is not considered likely due to a lack of favorable structures.

3.1.5.2 Conventional Natural Gas

Conventional natural gas reserves include resources that may be produced at the surface from a well bore as a consequence of natural pressure within the subsurface reservoir; and the maintenance of reservoir pressure by means of water or gas injection (U.S. Geological Survey [USGS], BLM, and Forest Service 1990). Conventional natural gas has been observed during drilling in both the North and South areas in the Ferron Sandstone and in the South Area in the Dakota Group. There is some conventional production from the Ferron, along with CBM, in at least one of Texaco’s CBM wells. In addition, Chandler’s existing wells are producing conventional gas from the Ferron (Aubry 1998). Conventional natural gas is produced west of the Project Area in the Clear Creek and Flat Canyon fields and to the south in the Ferron field. The Clear Creek field produces from the Ferron Sandstone. The Flat Canyon field (include both the East Mountain and the Indian Creek fields) produces from the Ferron Sandstone and from the Dakota Group. The Ferron field produces gas from the Ferron Sandstone.

Carbon dioxide production was established at the Farnham Dome field, to the east of the Project Area. Although more than 2 billion cubic feet of carbon dioxide have been produced from that field, there is no current production. In the Gordon Creek field to the west, shows of carbon dioxide have been reported in the Coconino Sandstone, the Sinbad Member of the Moenkopi Formation, and the Kaibab Limestone. Based upon discussions with operators, carbon dioxide is presently being produced from River Gas, Anadarko, and Texaco wells within and near the Project Area. Operators have indicated that all wells produce in the range of 2 to 20 percent carbon dioxide with an average of 10 percent (McKee 1998).

There is a potential for undiscovered conventional natural gas throughout the Project Area. Stratigraphic traps within or adjacent to the deltaic zones of the Ferron Sandstone have the highest potential for conventional natural gas reserves. There is potential to develop the existing Gordon Creek field, although it does not appear economically feasible at this time. Currently, River Gas is producing adjacent to the Miller Creek field and plans to develop it soon.

3.1.5.3 Coalbed Methane

Coals in the Mesaverde Group and the Ferron Sandstone Member of the Mancos Shale contain coalbed methane (CBM) reserves. These coals are classified as high-volatile B bituminous in the northern part of the Emery Coal Field (Doelling et al. 1979). Within the Project Area, CBM from the coals of the Ferron Sandstone would be extracted by the proposed Ferron Natural Gas Project. CBM is currently produced from 53 wells in the South Area and 15 in the North Area. These wells are predominantly located on private and state lands. As of March 1998, there were 140 wells in the area located between the North and South areas.

CBM is created along with water, carbon dioxide and nitrogen, as organic matter changes into coal (coalification). Some of the water and gasses become trapped as the coal seam is compacted. A coal seam is a dual porosity medium that consists of a solid matrix containing micropores and a natural fracture system known as cleats. Gas-saturated water occupies the cleats, while the bulk of the gas remains adsorbed to the walls of the matrix micropores. CBM reservoirs can contain from three to seven times more methane than a conventional natural gas reservoir because of large internal surface areas. Generally, higher ranked coals contain more trapped methane (BLM 1997c).

Adsorbed methane is produced from the coal by reducing the hydrostatic pressures (pressure exerted by water at any given point in a body of water at rest) within the formation. The reduced pressures allow gas to desorb from the coal micropores into the cleat system and flow toward low pressure areas.

Hydrostatic pressures are reduced by removing formation water. As water is produced, gas begins to desorb from the coal. In most wells, gas is produced immediately along with large quantities of water. Gas production gradually increases, and water production peaks then declines (within 3 to 4 years). As less water is produced, more gas desorbs and is produced at the well bore. Finally, gas production declines as water production remains low or ceases in the last stages of a well's production.

Portions of the Project Area are located within the Ferron Coalbed Gas Fairway, which extends from north of Price to south of Emery (Tabet 1995). The Ferron Fairway is 6 to 10 miles wide and at least 80 miles long. Ultimate recoverable reserves for the Ferron coalbed gas fairway are estimated at between 4 and 9 trillion cubic feet (Tabet et al. 1995). Total Ferron coal thickness in the Project Area is estimated to range from 0 to more than 40 feet.

3.1.5.4 Coal

Coal is not currently mined within the Project Area, although some coals of the Ferron Sandstone may be considered minable. Four principal coal fields are located in the vicinity of the Project Area: the Book Cliffs, the Wasatch Plateau, the Emery, and the Northern Emery. Coal beds in the Book Cliffs field occur in the

Blackhawk Formation. The Wasatch Plateau coal field is located west of the South Area on the Wasatch Plateau. Coal beds in this field also occur in the Blackhawk Formation. Coal in the Southern Emery coal field, located south of the South Area, is found in the Ferron Sandstone Member of the Mancos Shale. The Northern Emery field is located within and adjacent to the South Area. Coal reserves in the Ferron Sandstone in the Northern Emery coal field have been estimated at two billion tons based on burial depths of less than 3,000 feet (Doelling 1972 and Bunnell and Hollberg 1991). However, the Ferron coal has not been mined any closer than 15 miles south of the South Area.

There are 11 active coal mines, four inactive coal mines, two coal mines under development, and 12 in reclamation status in the Carbon-Emery counties area. In addition, numerous abandoned coal mines (pre-Surface Mining Control and Reclamation Act of 1977) are located in this area.

As shown on **Plate 3–1**, the South Area has three operational coal mines. Two mines operated by PacifiCorp and one by Co-Op Mining Company. The two active PacifiCorp coal mines are the Trail Mountain Mine and the Deer Creek Mine. These mines provide the fuel for the power needs of the Hunter and Huntington electric generation plants. The Deer Creek Mine is located on State Highway 31 adjacent to the Huntington power plant. The coal is transferred from the Deer Creek mine to the power plant by conveyor beltline located in the Deer Creek drainage. The Trail Mountain Mine is located on Forest Development Road 50040, in Cottonwood Canyon. Coal is transhipped by conveyor from the Trail Mountain Mine through the Cottonwood Mine (an inactive mine) to the Cottonwood Mine loadout. This coal is then trucked to the Hunter Plant. The Cottonwood Mine and Des-Bee-Dove Mine complex has been requested to be permanently abonadoned. The Co-Op Bear Canyon Mine is an active mine adjacent to the South Area. The Co-Op mine is located off State Highway 31. Trucks from the Co-Op mine haul coal to a rail loadout west of Wellington, Utah, for rail transport to designated markets.

As shown on **Plate 3–1**, the North Area has one adjacent operational coal mine. Cyprus Plateau's Willow Creek Mine, located on State Highway 191, is the only active mine in the vicinity of the North Area. The coal is transferred from the mine by conveyor beltline to a rail loadout on Highway 6.

3.1.5.5 Sand, Gravel, and Stone Resources

Commercially-exploitable deposits of sand and gravel are found within the South Area (USGS 1969). Significant deposits are found within the lower valleys of the larger streams, such as Huntington and Cottonwood creeks. There has been only limited development of these resources because of a lack of local demand.

Sandstone and other bedrock within the North and South areas is not currently exploited as a source of commercial materials.

Sand and gravel also occur extensively as residual deposits on tops of hills and benches. Emery County has two active pits in the South Area, which are under free use permits. There is one pit at the Sherman Wash north of Huntington Lake and the other is on Johnson Beach. The Sherman Wash pit also produces rock used as riprap.

3.2 WATER RESOURCES

3.2.1 Regional Overview

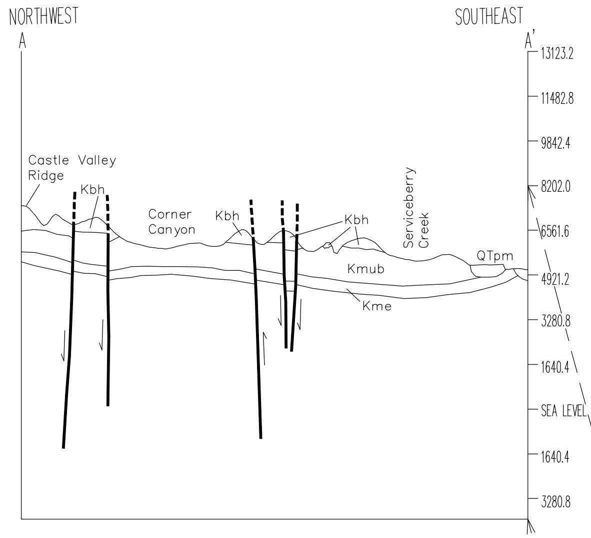
Groundwater in the Project Area occurring in geohydrologic units has been categorized into a series of major aquifers separated by confining units. Beginning at the surface and extending downward, these units are the Quaternary Alluvium (actually a group of discontinuous aquifers), the Mesaverde aquifer, the Mancos confining unit, the Dakota aquifer, the Morrison confining unit, the Morrison aquifer, the Curtis-Stump confining unit, the Entrada-Preuss aquifer, the Carmel-Twin Creek confining unit, the Navajo-Nugget aquifer, and the Chinle-Moenkopi confining unit (Freethey and Cordy 1991). The Ferron Sandstone member of the Mancos Shale, from which CBM and associated produced water would be extracted, is an aquifer in the Project Area. In general, units designated as aquifers are composed of sandstone, while confining units consist principally of shale, siltstone, limestone, and claystone (although confining units may include interbedded sandstone). The relationship between geohydrologic and stratigraphic units is shown in **Figure 3–1**, along with their associated regional stratigraphic descriptions and thicknesses.

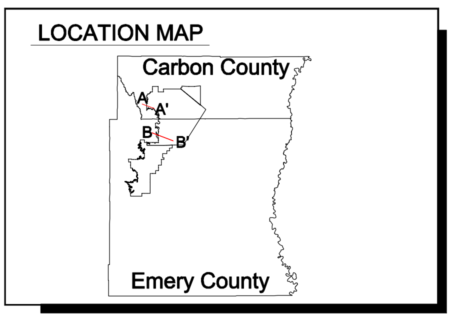
Regional groundwater flow in the shallower bedrock aquifers is generally from the Wasatch Plateau in the west toward aquifer outcrops and subcrops in the east. Recharge of the Ferron Sandstone occurs primarily along the fault zones of the Wasatch Plateau where precipitation is highest and extensional faulting allows for greater vertical recharge (**Figure 3–2**). Recharge to deeper aquifers in the Project Area, including the Navajo Sandstone, occurs, at least in part, along outcrops on the west side of the San Rafael Swell (Weiss 1987). Groundwater flows through interconnected pore spaces in the formations as well as through fracture systems. Discharge occurs where aquifers are dissected by deep canyons and where aquifers subcrop against the alluvium of the larger creeks. Other than in the highly-faulted areas of the Wasatch Plateau, there appears to be little vertical recharge or discharge between aquifers (Freethey and Cordy 1991).

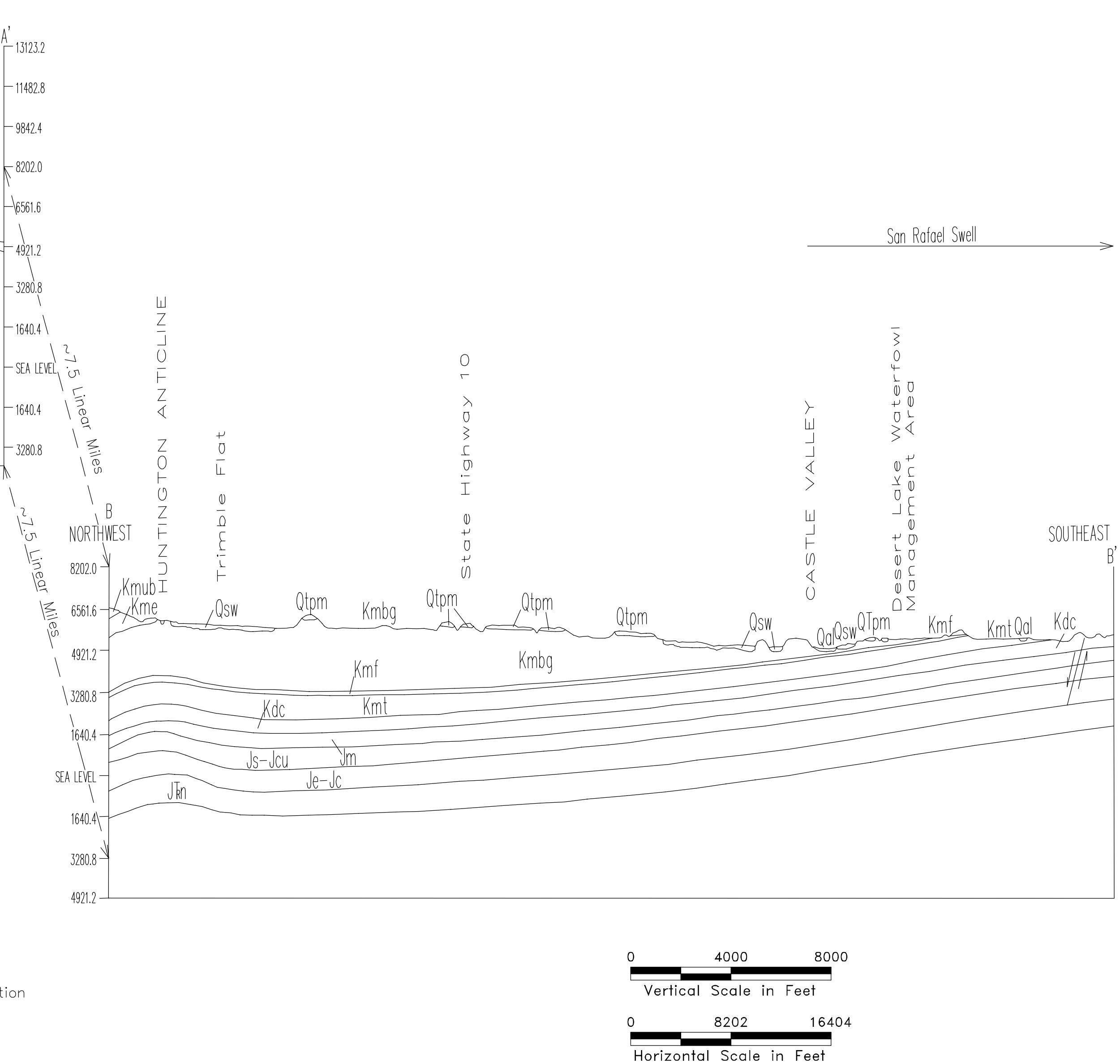
Only four of the above geohydrologic units are likely to be affected by the proposed project. The Quaternary Alluvium has the potential to be impacted by near-surface activities. The Ferron Sandstone would be affected by the withdrawal of CBM and produced water. The Entrada-Preuss and Navajo-Nugget aquifers would be affected by the injection of water produced from the Ferron Sandstone. The following discussions of groundwater flow, water quality, and water use focus primarily on these four units.

The Project Area is contained within the watersheds of the Price River and San Rafael River. The Price River in the North Area separates the Wasatch Plateau from the Book Cliffs. Various dry washes and ephemeral creeks of the Price River watershed flow through the North Area. These include Deadman Creek, Meads Wash, Cardinal Wash, and Hayes Wash. These channels generally flow south or southwest into the Price River. In the South Area, tributaries of the San Rafael River generally flow east and southeast from portions of Wasatch Plateau into Castle Valley. The perennial tributaries include Huntington Creek, Cottonwood Creek, Rock Canyon Creek, and Ferron Creek. Most channels draining the area are dry most of the year, and flow only in response to storm events. Water resources in the Project Area are shown on **Plate 3–2**. The Price and San Rafael Rivers drain into the Green River, which eventually drains into the Colorado River.

As drainages along the western portion of the South Area approach the higher elevations and amounts of precipitation typical of the Wasatch Plateau, they are more likely to be perennial, or have flow year-round. Similar to the distribution of perennial streams, identified springs are found near the western boundary of the South Area and shown on **Plate 3–2**.







LEGEND

Qal – Alluvium (Holocene)
Qsw – Slope wash (Holocene)
QTpm – Pediment mantle (Holocene to Pliocene)
Kbh – Blackhawk Formation (Upper Cretaceous)
Kmub – Upper part of Blue Gate Member
Kme – Emery Sandstone Member
Kmbg – Blue Gate Member
Kmf – Ferron Sandstone Member
Kmt – Tununk Member
Kdc – Dakota Sandstone and Cedar Mountain Formation
Dakota Sandstone (Upper Cretaceous)
Jm – Morrison Formation (Upper Jurassic)
Js – Summerville Formation (Middle Jurassic)
Jcu – Curtis Formation (Middle Jurassic)
Je – Entrada Sandstone (Middle Jurassic)
Jc – Carmel Formation (Middle Jurassic), Lower Unit
JTn – Navajo Sandstone (Jurassic and Upper Triassic?)

Source: Witkind and Weiss, 1991; Witkind, 1988

Figure 3-2
Northwest-Southeast Geologic Cross-Section of Castle Valley

Surface water quality is directly influenced by higher amounts of precipitation associated with the mountains of the Wasatch Plateau and the composition of the rocks in the area. Regionally, the lowest total dissolved solids (TDS) concentrations occur at higher elevations and increase significantly as the streams flow away from the mountains across the saline soils of the Mancos Shale Lowlands.

3.2.2 Groundwater

3.2.2.1 Groundwater Flow

3.2.2.1.1 Quaternary Alluvium

Quaternary Alluvium along major streams typically forms the shallowest accessible aquifers in the Project Area. Principal alluvial aquifers include those deposits associated with the main stems and tributaries to the Price River, San Rafael River, Huntington Creek, Cottonwood Creek, Rock Canyon Creek, and Ferron Creek. Alluvial aquifers are generally recharged by streams during periods of high flow and discharge to the same stream during periods of low flow. They also are recharged by precipitation.

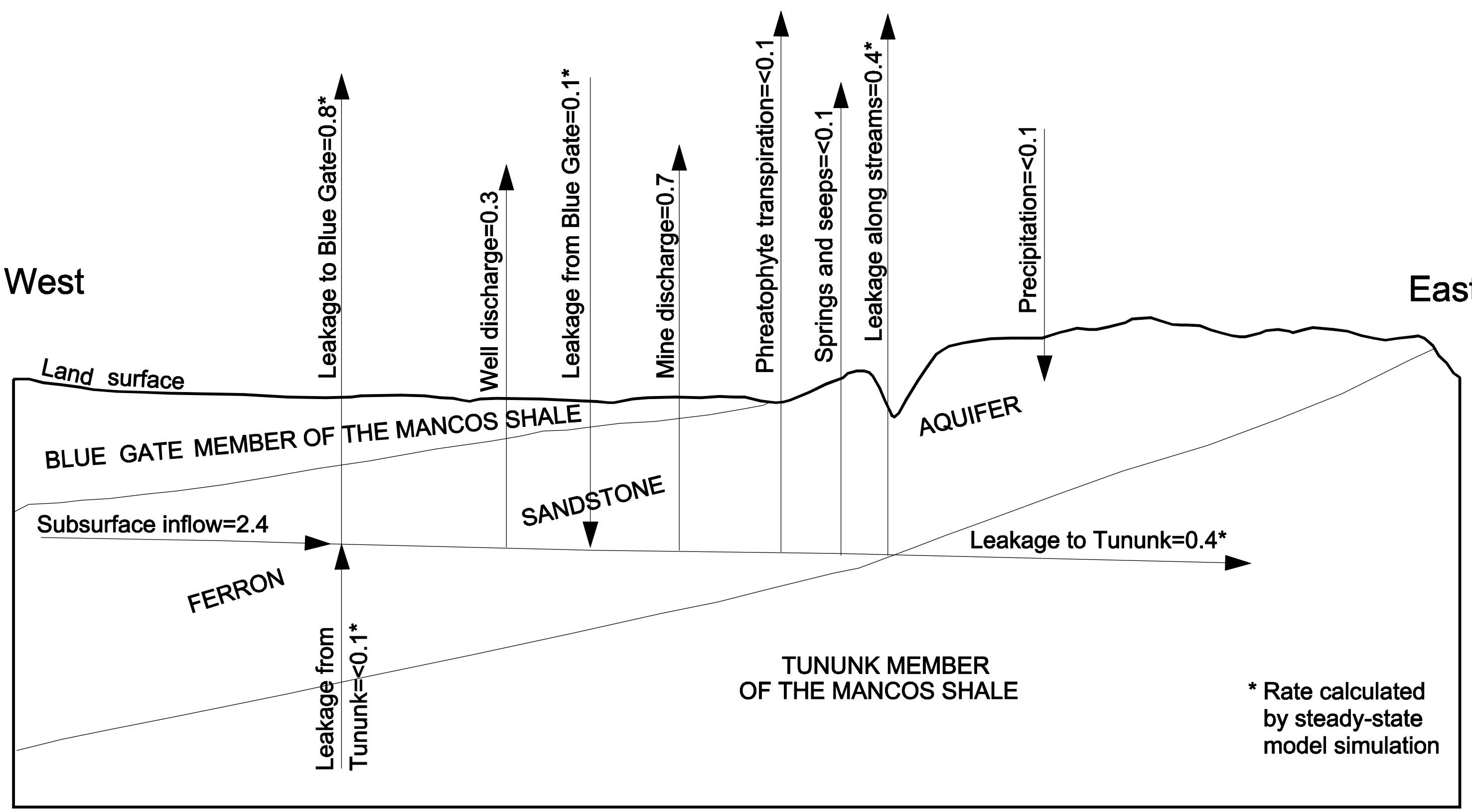
River alluvium can be a pathway for recharge of underlying aquifer units. East of the Wasatch Plateau and throughout most of the Project Area, the alluvium overlies the impermeable Mancos Shale. Alluvium is deposited by streams and is typically composed of varied, non-indurated mixture of gravel, sand, silt, and clay. Due to the textural variability, aquifer properties affecting water movement through alluvium can vary greatly. Rate of flow through alluvial materials can range from 1×10^{-6} feet per day for clay to 1×10^{4} feet per day for gravel (Freeze and Cherry 1979). The discontinuous nature of alluvial deposits, together with their inconsistent aquifer properties, prohibits them from being considered a regionally continuous aquifer, even though they may be locally significant.

3.2.2.1.2 Ferron Sandstone Aquifer

Within the Project Area, the Ferron Sandstone aquifer consists of the whole thickness of the Ferron Sandstone Member of the Mancos Shale (Lines and Morrissey 1983). Depths to the top of the Ferron Sandstone in the vicinity of the Project Area range from about 80 feet along the eastern edge to 6,000 along the western edge (Tabet et al. 1995). Thickness varies from 180 to 300 feet (Hintze 1988). Dips range from 2 degrees to 10 degrees toward the northwest, and the member generally thickens downdip and to the south.

Water in the aquifer is confined between shale and siltstone beds within the aquifer and between enclosing shales of the overlying Blue Gate and underlying Tununk members of the Mancos Shale (Lines and Morrissey 1983). The complete thickness of the Ferron Sandstone is usually saturated with water within a short distance of the outcrop area.

In the southern third of Castle Valley, which includes the South Area, water moves through the aquifer from areas of subsurface recharge in the west and northwest toward areas of natural discharge along the Ferron outcrop. The order-of-magnitude estimates presented in **Figure 3–3** indicate discharge exceeds recharge by about 0.1 cubic foot per second; however, the precise degree of imbalance between recharge and discharge is not known. The largest source of recharge to the Ferron Sandstone aquifer is precipitation on the Wasatch Plateau to the west-northwest of Castle Valley that moves downward into the buried Ferron Sandstone through a highly permeable zone of overburden along the Paradise Valley-Joes Valley fault system (Lines and Morrissey 1983).



Note: Adapted from Lines and Morrissey, 1983-Figure 12

Figure 3-3
Diagrammatic section showing sources of recharge to and discharge from the Ferron sandstone aquifer in the Emery area, 1979. Recharge and discharge values are in cubic feet per second.

Much of the water from precipitation that recharges the aquifer at the outcrop to the east/southeast of the South Area close to the San Rafael Swell is likely discharged close to the recharge areas by leakage to underlying strata and to stream alluvium.

In the northern two-thirds of Castle Valley, which includes the North Area, recharge to the aquifer may be limited to a small amount of recharge from precipitation along a narrow strip of Ferron outcrop on the west flank of the San Rafael Swell (Lines and Morrissey 1983). Recharge by subsurface inflows from the west is likely prevented by the offset of the Ferron Sandstone along faults and the resulting break in connection and supply of subsurface inflow water to these northern parts of the aquifer.

3.2.2.1.3 Entrada-Preuss Aquifer

The Entrada-Preuss aquifer consists of the Preuss Sandstone in Castle Valley (Freethey and Cordy 1991). Depths to the top of the Entrada Sandstone in the region range from 1,500 to 4,800 feet (Hunt 1998). Thickness varies from about 150 feet to 950 feet (Hintze 1988). Dips again range from about 2 degrees to 10 degrees toward the west and northwest. Water levels indicate the entire thickness of the aquifer is saturated and that a large volume of water is stored in the aquifer. The aquifer is confined by siltstones of the overlying Curtis Formation and the shaley siltstones and anhydrite beds of the underlying Carmel-Twin Creek.

3.2.2.1.4 Navajo-Nugget Aquifer

The Navajo-Nugget aquifer consists of the Glen Canyon Group (Navajo Sandstone, Wingate Sandstone, and the Kayenta Formations) in the vicinity of Castle Valley and the Project Area. Depths to the top of the Glen Canyon Group range from about 2,000 to 7,000 feet (Witkind 1988). Aquifer thickness ranges from 570 to 970 feet (Hintze 1988). Dip is generally toward the west and ranges from 3 to 7 degrees.

The presence of a thrust fault that created a rubblized zone just below the middle anhydrite zone of the overlying Carmel formation is indicative of past tectonic activity in the Project Area. This fault has been detected in Price CBM Well D–3 at a depth of 5,200 ft, in Price CBM Well D–4 at 5,650 ft, and in Price CBM Well D–5 at 6,220 ft. (Conway 1997). In addition, fracture modeling has shown that horizontal stresses are present in the Navajo formation. Because of the absence of significant vertical displacement, it is difficult to determine whether this tectonic activity has resulted in thrust faults in the Navajo formation. Such faults, if they exist, could significantly affect flow patterns of ground water.

Regionally, the Navajo-Nugget Aquifer is an important aquifer (Freethey and Cordy 1991). In the vicinity of the San Rafael Swell, the aquifer's strata are reported to be very permeable and contain relatively fresh water at a shallow depth (Hood and Patterson 1984). Water in the aquifer is confined by crosscutting sedimentary structures and mudstone interbeds within the aquifer and by shales, limestones and anhydrite of the overlying Carmel-Twin Creek confining unit and underlying shales and sandy shales of the Chinle-Moenkopi confining unit (Freethey and Cordy 1991, Conway 1997). East and up-dip of the Project Area, water in the aquifer in and near the outcrop is unconfined.

Water moves through the aquifer beneath the Project Area mostly to the north in the South Area and to the east in the North Area (Hood and Patterson 1984). These flows are part of a clockwise movement of groundwater in the aquifer around the north end of the San Rafael Swell that continues generally southeast along the east flank toward the Green River (**Figure 3–4**). A notable exception to this movement occurs in the southern portion of the South Area, where discharge from the aquifer is principally to the San Rafael

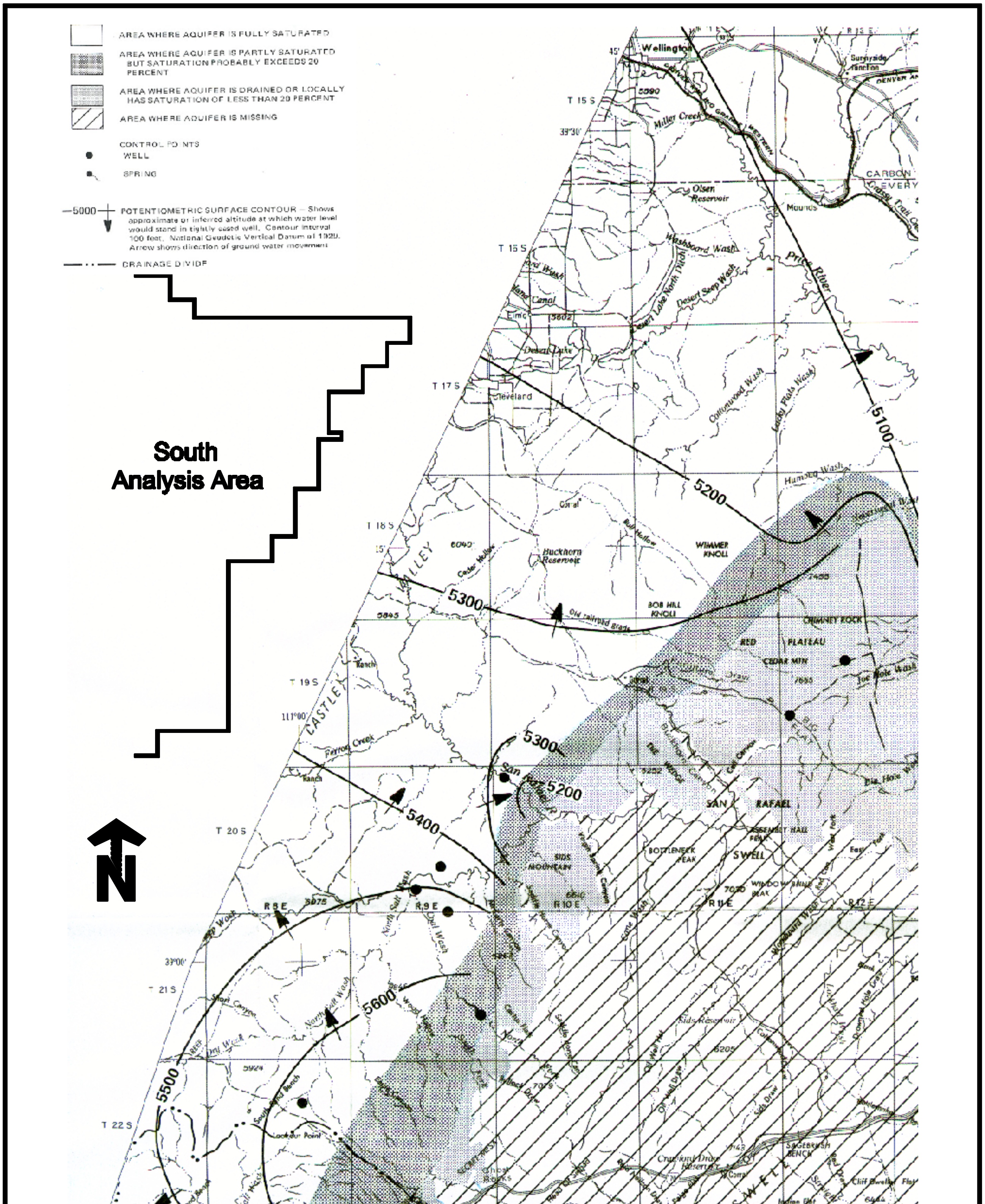


Figure 3-4
Potentiometric Surface of Navajo Sandstone Aquifer North and West of San Rafael Swell

Source: Hood and Patterson, 1984

River alluvial system west of the San Rafael Swell. This area of discharge coincides with where the river's course and alluvial deposits incise the aquifer adjacent to the San Rafael Swell (Hood and Patterson 1984). Recharge to that portion of the Navajo-Nugget Aquifer beneath the Project Area is from precipitation infiltrating into outcrops of the Glen Canyon Group, which are exposed along the western and northern flanks of the San Rafael Swell. This area of recharge is located generally southeast of the Project Area.

The lower San Rafael and Green Rivers east of the Swell receive lesser amounts of discharge (Hood and Patterson 1984).

3.2.2.2 Groundwater Quality

While the quality of groundwater in the Quaternary Alluvium is relatively good and supports a variety of beneficial uses, bedrock aquifers in the Project Area tend to have groundwater with very high concentrations of dissolved minerals and, thus, have limited domestic and commercial utility. The high concentrations of total dissolved solids (TDS) result from the presence of easily dissolved minerals in rocks within the formation and adjacent confining units and from the distance through which the groundwater has passed from the recharge areas to the Project Area. **Table 3–1** summarizes available water quality for the aquifers in the Project Area and compares that data to Utah groundwater quality standards.

3.2.2.2.1 Quaternary Alluvium

Because the primary source of water stored in the Quaternary Alluvium is the adjacent stream and because the stream and groundwater remain hydraulically connected, Quaternary Alluvium water quality is very similar to stream water quality. Water quality data for streams in the Project Area is presented in **Section 3.2.3.2**.

3.2.2.2.2 Ferron Sandstone Aquifer

In the southern third of Castle Valley, overall water quality of the Ferron Sandstone aquifer, as defined by presence of dissolved solids, decreases eastward from the Paradise Valley-Joes Valley fault system to the outcrop (Lines and Morrissey 1983). This west to east directional gradient generally coincides with the direction of groundwater movement. TDS concentrations also increase from the bottom to the top of the aquifer in areas downdip from the outcrop.

Water quality data from CBM wells in the Price CBM EIS area (produced water collected for disposal in Price CBM Wells D–1 and D–3), CBM wells in the South Area (produced water collected for disposal in Texaco Well SWD#1), and results from the Buzzard Bench field show TDS concentrations ranging from 6,459 to 23,099 mg/L, with very high concentrations of sodium (1,770 to 2,600 mg/L), chloride (1,412 to 7,450 mg/L), and bicarbonate (2,050 to 10,425 mg/L) (**Tables 3–1** and **3–2)**. Total iron concentrations range from < 0.1 to 180 mg/L, averaging 24.1 mg/L and hydrogen sulfide concentrations range from 0 to 62 mg/L and average 7.8 mg/L. Major cation and anion relationships for Wells D–1, D–3, and SWD#1 are illustrated in the form of Stiff diagrams (**Figure 3–5**) and a trilinear diagram (**Figure 3–6**). Groundwater from all three are similar with respect to major ion chemistry and are classified as sodium chloride water types.

While available analytical data do not include many of the parameters regulated by Utah's Administrative Rules for Ground Water Quality Protection (R317–6, Utah Administrative Code), TDS and barium (6.2 mg/L) concentrations make this water unsuitable for drinking water.

Table 3–1
Groundwater Quality in the Ferron Sandstone and Navajo-Nugget Aquifers

		Ferron Sandstone Aquifer Produced Water Collected for Disposal in			Navajo-Nugget Aquifer						
Parameters	**Utah Groundwater Quality Standards**	**Price CBM Well D–1**	**Price CBM Well D–3**	**Texaco Well SWD #1**	**Price CBM Well D–1**	**Price CBM Well D–3**	**Price CBM Well D–1**	**Price CBM Well D–5**	**Texaco SWD #1**	**Texaco SWD #2**	**Anadarko SWD #1**
Regulated Constituents[1]											
pH (standard units)	6.5 – 8.5	7.93	8.71[2]	7.2	5.96	6.14[2]	7.02 – 7.14	6.9–7.11	5.8		7.3
Nitrate (as N)	10									<0.08	
Nitrite (as N)	1									0.005	
Total Nitrate/Nitrite (as N)	10									<0.08	
Barium	2	6.2			0.2						40–70
Total Dissolved Solids		6,459	8,402	7,010	152,428	217,264	137,116– 138,260	87,140–177,624	21,600	13,100	64,997–107,810
Pristine Groundwater	500										
Drinking Water Quality Groundwater	500 – 3,000										
Limited Use Groundwater	3,000 – 10,000										
Saline Groundwater	> 10,000										
Major Cations											
Calcium		30.9	17.5	121	3,115	1,390	855 – 898	930–1,440	1,920	126	1,560–1,680
Magnesium		11.4	15.8	<0.1	626	465	384 – 389	272–530	1,530	19.1	146–366
Sodium		1,770	2,600	2,300	41,100	78,500	47,850– 48,620	25,100–48,100	3,250	4,240	22,597–38,658
Potassium		41.7	63	30	1,200	1,500			250	248	
Hardness		124	109	303	10,356	5,386			11,100	467	
Major Anions											
Carbonate		0	420[2]		0	0[2]	0	0	0	<3	0
Bicarbonate		3,180	3,890	3,370	855	705	2,550– 2,610	1,850–2,750	478	1,820	3,416–3,904
Chloride		1,778	2,518	1,450	93,130	116,163	69,652– 71,240	48,779–92,567	10,370	4,690	33,000–55,000
Sulfate		1.2	< 1.6	274	2,602	3,390	3,150–3,200	0[2]	2,030	2,400	3,750–9,800
Other Constituents											
Strontium		2.9			13	< 5.0					0.0
Aluminum		0.38	< 5.0		< 10.0	10.9[2]					
Iron		1.76	< 2.5[2]	< 0.1	67				227	97.8	5.7–19.5
Phosphate		< 0.02			< 0.02						

Notes:
1. Concentration may have been affected by sample handling/preservation.
2. Units are mg/L unless stated otherwise

Sources: Himes 1996, UDOGM 1996 and 1997, Hurst 1994, anonymous 1997

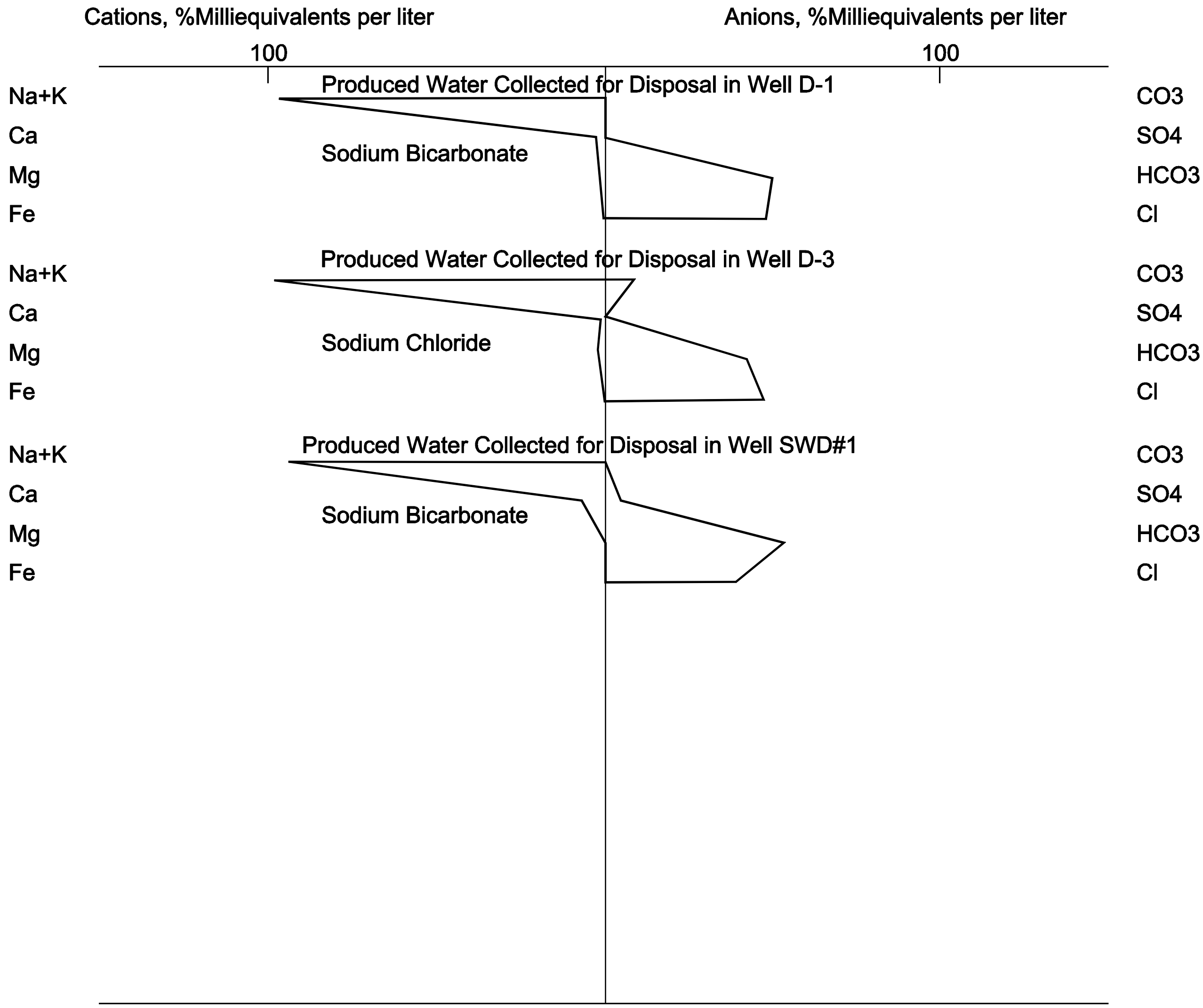
Table 3–2
Ferron Water Quality Produced From the Buzzard Bench Field[1]

Section	Well No.	Area	pH	H_2S	CO_3	HCO_3	Chloride	Sulfate	Calcium	Magnesium	TDS	Total Iron
34	12	Grimes Wash	7.5	17	0	8,875	1,800	0	50	11	15,206	18.4
35	14	Grimes Wash	8	5	30	9,540	1,900	0	44	2	16,805	10.8
35	13	Grimes Wash	8	20	0	8,069	1,412	0	42	12	13,415	6.4
2	11	Grimes Wash	7.9	16	0	7,300	1,660	0	31	42	12,780	10.4
2	48	Grimes Wash	7.8	25	0	7,925	2,300	90	40	6	14,821	11.8
2	49	Grimes Wash	7.8	22	0	6,440	3,540	440	72	19	15,358	55
2	50	Grimes Wash	7.8	18	0	6,950	1,950	600	54	13	13,660	41.4
		AVERAGE	**7.8**	**18**	**4**	**7,871.3**	**2080.3**	**161**	**48**	**15**	**14,578**	**22.6**
4	44	Anadarko	8	5	150	7,900	2,100	0	48	7	14,834	1.3
9	45	Anadarko	8	4	77	10,425	3,450	0	49	9	20,258	7.3
10	47	Anadarko	7.6	8	0	8,933	4,600	0	51	12	19,854	3.2
10	42	Anadarko	7.5	7	0	8,200	2,500	0	44	7	15,378	9.1
10	43	Anadarko	7.6	18	0	7,900	2,100	0	32	2	14,422	6.9
		AVERAGE	**7.7**	**8**	**45**	**8,671.6**	**2950.0**	**0**	**45**	**7**	**16,949**	**5.6**
7	64	Creek West	7.6	0	0	7,300	1,950	0	25	4	13,290	21.5
8	62	Creek West	7.5	11	0	9,200	5,000	0	20	17	20,770	43.0
8	61	Creek West	8.4	0	0	6,100	2,500	0	80	0	12,480	23.0
8	46	Creek West	7.4	19	0	10,100	3,000	107	52	103	19,190	180.0
9	60	Creek West	7.6	7	0	9,350	3,150	50	30	20	23,099	25.5
		AVERAGE	**7.7**	**7**	**0**	**8,410.0**	**3120.0**	**31**	**41**	**29**	**17,766**	**58.6**
9	59	Creek Central	8	12	0	2,050	6,350	0	56	11	13,331	75
10	58	Creek Central	7.7	62	0	9,100	3,900	0	29	25	18,930	38.1
15	67	Creek Central	8.3	0	0	8,200	3,900	0	8	7	17,676	25
16	65	Creek Central	7.8	10	0	8,200	7,000	0	48	10	22,873	24
16	66	Creek Central	7.5	2	0	6,200	7,450	0	68	11	22,786	20.4
		AVERAGE	**7.9**	**17**	**0**	**6,750.0**	**5720.0**	**0**	**42**	**13**	**19,119**	**36.5**
14	55	Creek East	7.6	2	0	6,700	1,600	0	39	10	11,873	2.6
23	8	Creek East	8.1	2	0	9,300	3,900	0	17	1	19,126	10
24	57	Creek East	8.3	2	0	7,300	3,900	0	32	7	16,494	16
		AVERAGE	**8.0**	**2**	**0**	**7,766.7**	**3133.3**	**0**	**29**	**6**	**15,831**	**9.5**

Table 3–2 (continued)
Ferron Water Quality Produced From the Buzzard Bench Field[1]

Section	Well No.	Area	pH	H_2S	CO_3	HCO_3	Chloride	Sulfate	Calcium	Magnesium	TDS	Total Iron
26	2	Buzzard Bench	7.9	11	120	7,770	3,052	0	32	6	16,242	2.8
26	4	Buzzard Bench	8	3	136	6,910	3,145	0	28	6	16,459	5.4
35	6	Buzzard Bench	7.8	4	232	7,279	2,104	35	58	16	12,719	23.5
35	5	Buzzard Bench	8.1	4	325	10,087	3,934	0	21	14	20,714	3.1
34	7	Buzzard Bench	7.8	10	222	7,024	1,759	0	38	6	12,484	15.6
		AVERAGE	**7.9**	**6**	**207**	**7,814.0**	**2,798.8**	**7**	**35**	**10**	**15,724**	**10.1**
	1	SWD	7.8	26	109	7,853	2,490	2	36	10	14,948	6.1
		AVERAGE	**7.8**	**11**	**45**	**7,886.5**	**3,206.3**	**43**	**41**	**14**	**16,525**	**24.1**
		MEDIAN	7.8	8	0	7,900.0	3,000.0	0	40	10	15,378	13.7
		MINIMUM	7.4	8	0	7,900.0	1,412.0	0	8	0	11,873	1.3
		MAXIMUM	8.4	62	325	10,425.0	7,450.0	600	80	103	23,099	180.0

Note:
1. Units are mg/L for all parameters except pH, which is SU (Standard Units).

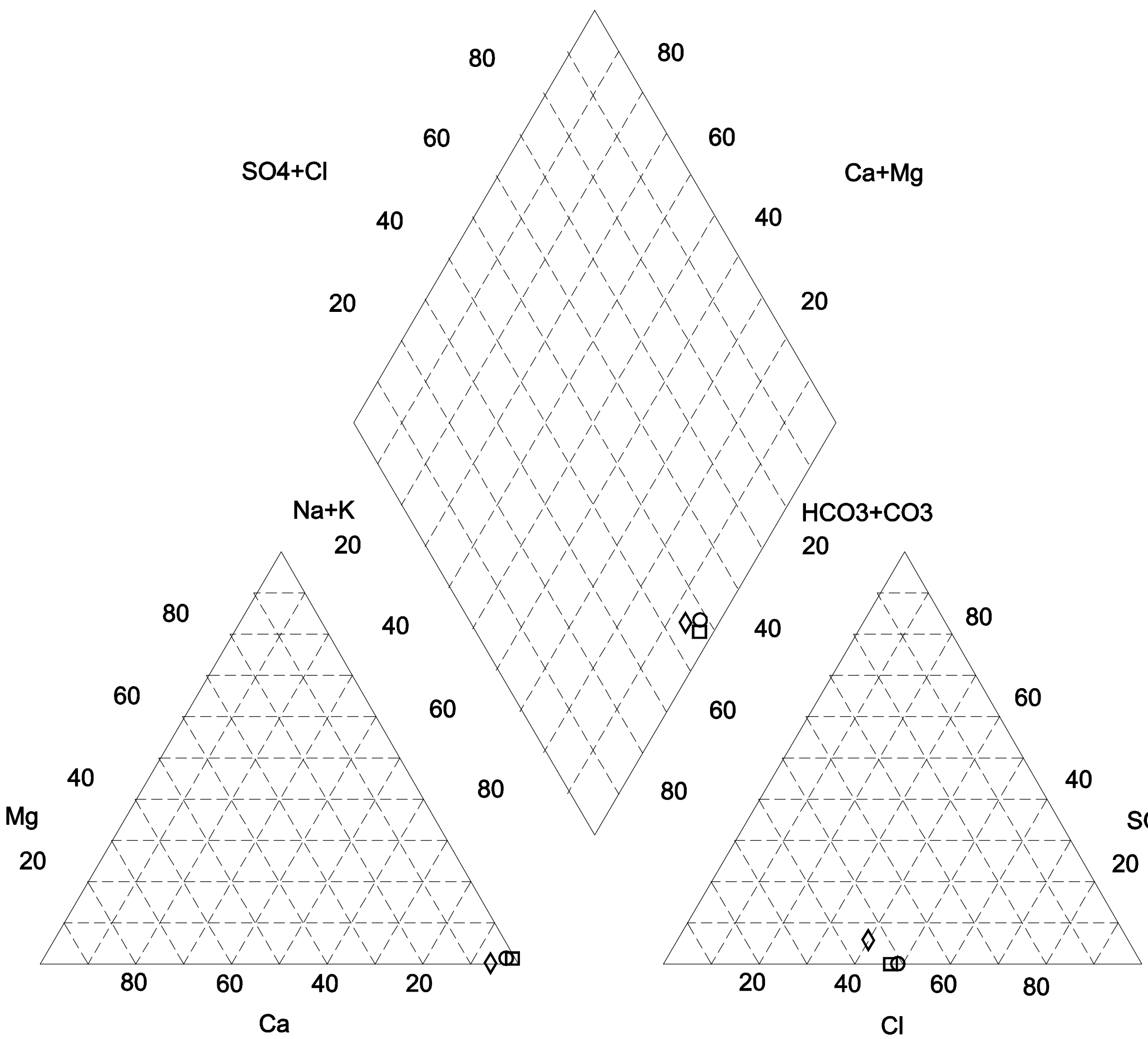


LEGEND

Well D-1
03/04/1994
River Gas
Well D-3
05/01/1996
River Gas
Well SWD#1
01/10/1996
Texaco

647sand-stif.dwg

Figure 3-5
Stiff Diagrams for wells in the Ferron Sandstone Aquifer Produced Water



LEGEND

○ Produced Water Collected for Disposol in Well D-1
03/04/1994
River Gas

□ Produced Water Collected for Disposol in Well D-3
05/01/1996
River Gas

◊ Produced Water Collected for Disposol in Well SWD#1
01/10/1996
Texaco

647sand-tri.dwg

Figure 3-6
Trilinear Diagrams for wells in the Ferron Sandstone Aquifer Produced Water

3.2.2.2.3 Entrada-Preuss Aquifer

Water quality in the Entrada-Preuss is highest near the recharge areas on the west flank of the San Rafael Swell (TDS less than 1,000 mg/L) and deteriorates with distance from the recharge area (Freethey and Cordy 1991).

3.2.2.2.4 Navajo-Nugget Aquifer

Although fresh water occurs in the aquifer along the perimeter of the San Rafael Swell near the recharge area, water quality degrades with increasing distance from the area of recharge (**Figure 3–7**). Water quality data from four wells in the Price CBM EIS area (Price CBM wells D–1, D–3, D–4, and D–5) and two wells in the South Area (Texaco Wells SWD#1 and SWD #2) show TDS concentrations ranging from 13,100 to 217,264 mg/L, with very high concentrations of calcium (126 to 3,115 mg/L), magnesium (19.1 to 1,530 mg/L), sodium (3,250 to 78,500 mg/L), potassium 248 to 1,500 mg/L), chloride (4,690 to 116,163 mg/L), sulfate (2,030 to 9,800 mg/L), and bicarbonate (478 to 3,904 mg/L). Major cation and anion relationships for Wells D1, D3, D5, SWD#1, and SWD #2 are illustrated in the form of a Stiff diagram (**Figure 3–8**) and a trilinear diagram (**Figure 3–9**). Groundwater from all three are similar with respect to major ion chemistry and are classified as sodium chloride water types.

While available analytical data do not include many of the parameters regulated by Utah's Administrative Rules for Ground Water Quality Protection, TDS concentrations make this water unsuitable for virtually all potential uses.

3.2.2.3 Groundwater Use

Water rights in the state of Utah are administered by the Utah Department of Natural Resources (UDNR) Division of Water Rights. This agency has the authority to determine whether or not a water right application or an application to change an existing water right will be approved based on state laws and statutes, including those of the proposed project.

3.2.2.3.1 Quaternary Alluvium

The depths and locations of wells in the Project Area suggest that the majority are completed in the Quaternary Alluvium. These aquifers therefore constitute a locally significant source of water in the Project Area.

3.2.2.3.2 Ferron Sandstone Aquifer

The largest quantities of available water from the Ferron Sandstone aquifer are within about 2 miles of the Paradise Valley-Joes Valley fault system in the vicinity of the South Area (Lines and Morrissey 1983). Pumped wells could produce 100 to 500 gallons per minute. Potential production from wells located in the southern part of Castle Valley is estimated to be 10 to 50 gallons per minute (gpm). In the northern two-thirds of Castle Valley, yields from individual wells in the Ferron Sandstone aquifer would likely be less than 10 gpm.

Because of the locally poor water quality and the depth of the aquifer, the Ferron Sandstone aquifer is not a significant source of usable water in the Project Area. However, greater use is locally made of the aquifer east of the Project Area in a small area on the west flank of the San Rafael Swell where the top of the aquifer is at a shallower depth and the water quality is higher. The water use from the Ferron in this area is for stock watering purposes.

3.2.2.3.3 Entrada-Preuss Aquifer

Because of its considerable depth and poor water quality, the Entrada-Preuss aquifer does not appear to be a source of usable ground water within or adjacent to the Project Area.

3.2.2.3.4 Navajo-Nugget Aquifer

The Navajo-Nugget aquifer contains water suitable for stock irrigation, and domestic uses within a few miles of the aquifer outcrop both east and west of the San Rafael Swell and in most of the San Rafael Desert, South of Green River (Hood and Patterson 1984). However, as of 1995, the Utah Division of Water Rights regional engineer reported that no water was being withdrawn from the Navajo-Nugget aquifer in the Castle Valley area. Nevertheless, yields of more than 1,000 gpm to individual wells are locally possible in the area (Hood and Patterson 1984).

3.2.3 Surface Water

3.2.3.1 Water Quantity

Average annual precipitation in the project vicinity varies by elevation. Precipitation ranges from less than 6 inches in the lower elevations (town of Green River, 4,100 feet above mean sea level [amsl]) to more than 40 inches in the headwaters at higher elevations (Wasatch Plateau, 9,000 to 12,000 feet amsl). In these headwaters, 70 percent or more of the total annual precipitation generally falls as snow during October through April (UDNR 1972 and 1982). The Price hydrologic subarea, which includes the cities of Price and Helper and encompasses the North Area, has an average annual precipitation of 11.7 inches. The Cottonwood-Huntington hydrologic subarea of the San Rafael River Basin, which includes the South Area, has an annual precipitation of 6.1 to 8.4 inches.

The wettest months in the Price and Cottonwood-Huntington subareas are July through October. During this period, the areas receive about 41 and 45 percent of the total annual precipitation, respectively. Pan evaporation rates are 62 inches per year and lake evaporation rates are 43 inches per year (National Oceanic and Atmospheric Administration 1979). For the Project Area, the highest evaporation rates usually occur during June, July, and August, whereas the lowest evaporation rates occur during December, January, and February. About 79 percent of the total annual evaporation occurs between May and October and 55 percent of the annual evaporation occurs in June and July. One to four percent occurs during December through February (Utah Division of Water Resources 1975 and 1979).

Most drainages in the area are ephemeral, flowing in response to snowmelt or storm events. The major perennial streams and tributaries in the Project Area experience their highest flows during May, June, and July, accounting for 50 to 70 percent of the annual stream flow. These peak flows are the result of melting snow that accumulates in the higher elevations from October through April (Waddell et al. 1981). The lowest flows occur during the winter months when stream flow is more dependent on bedrock discharge (Waddell et al. 1981).

Average annual flow data have been compiled from USGS stream gaging stations (USGS 1997) and from STORET sites to provide a perspective of perennial stream flow. Upstream from the North Area, the Price

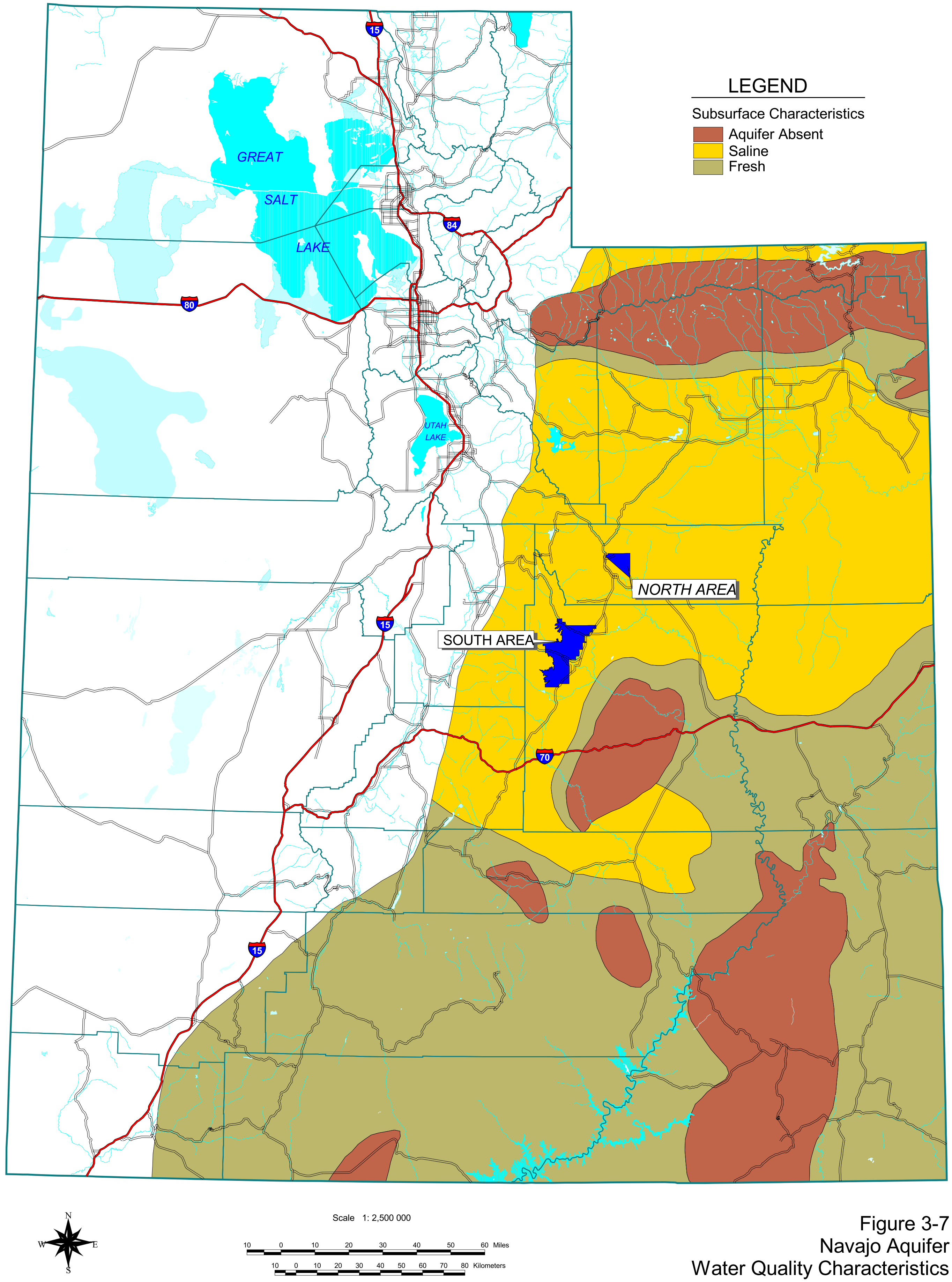


Figure 3-7
Navajo Aquifer
Water Quality Characteristics

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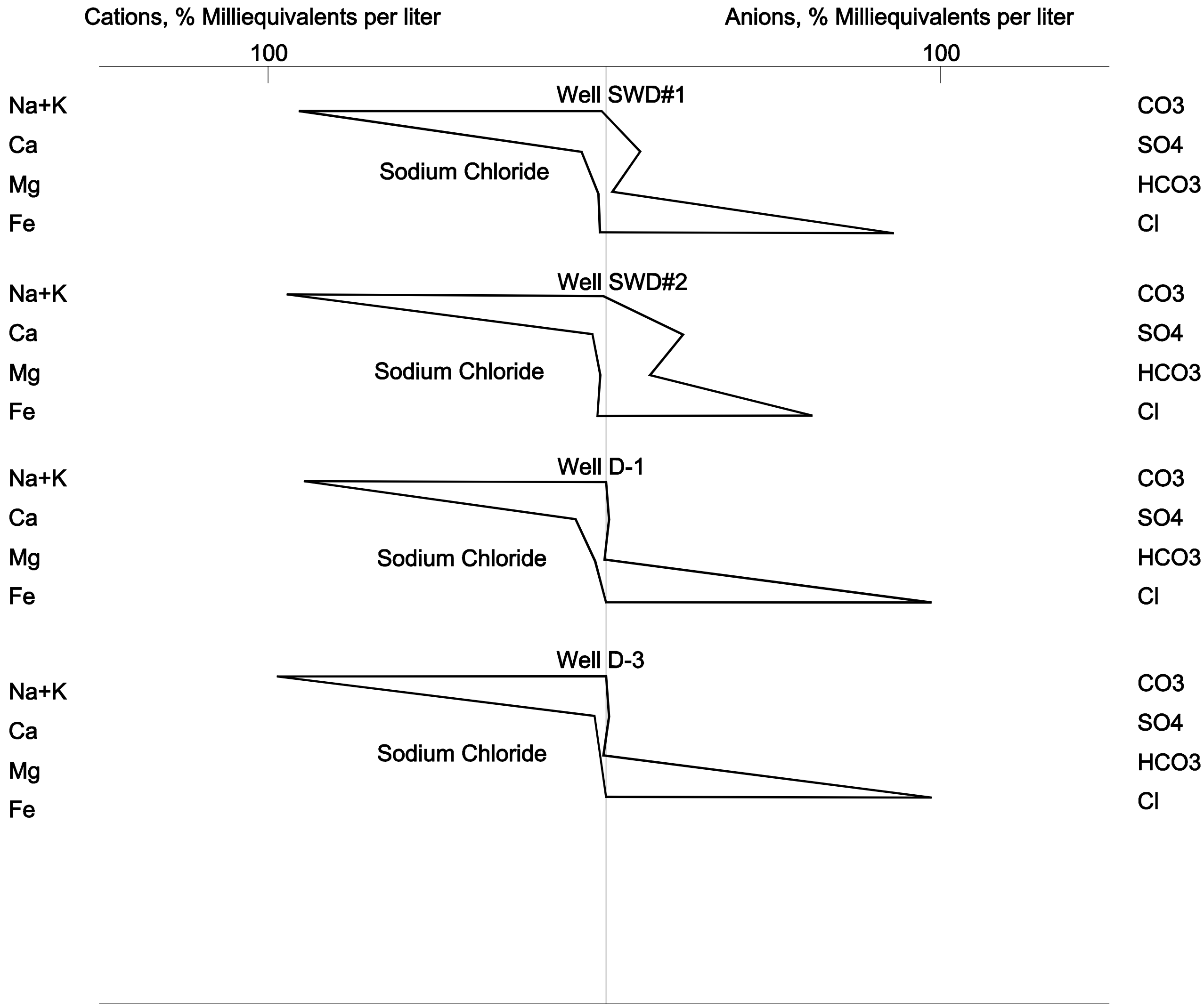


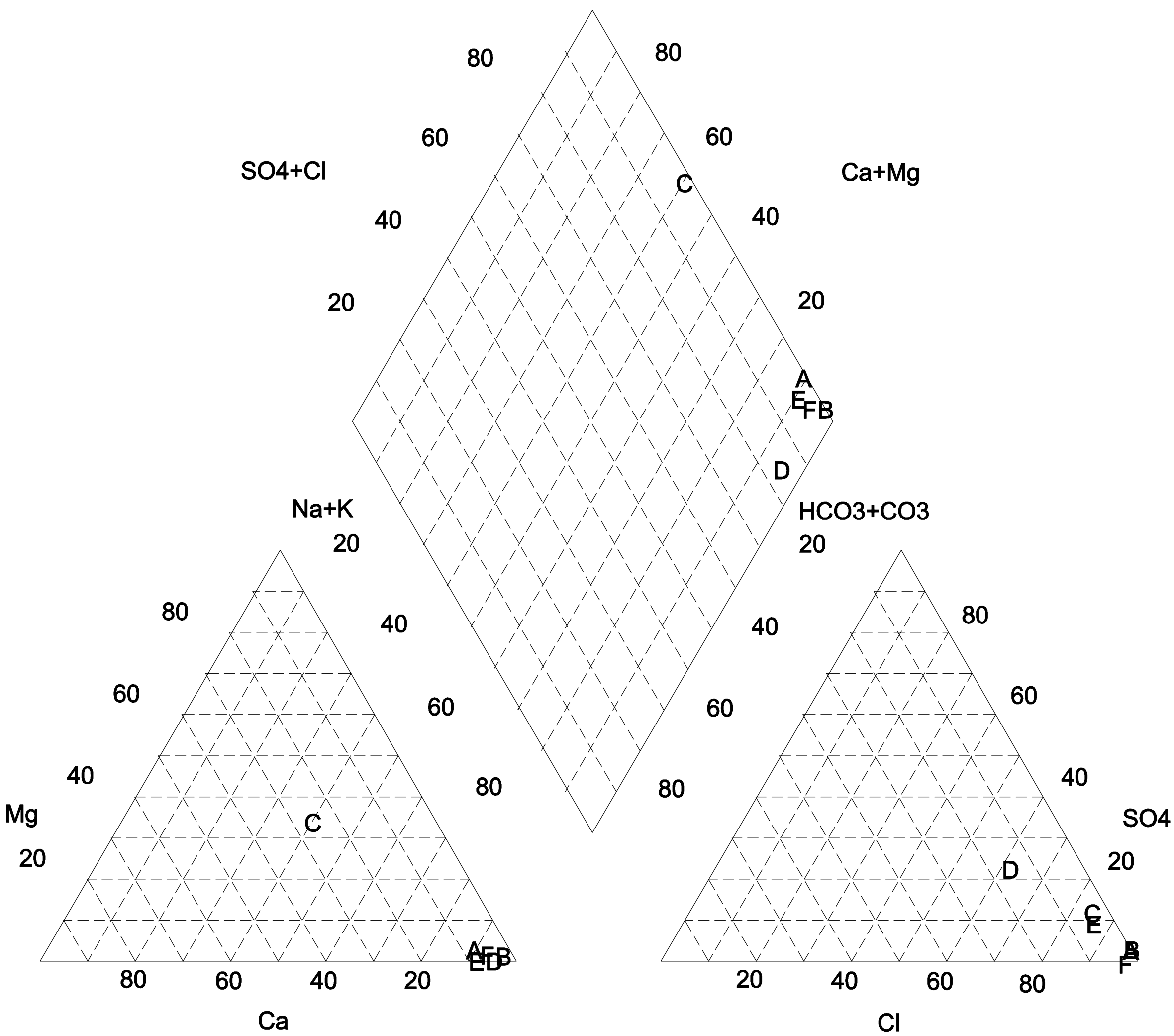
LEGEND

Well SWD#1, 6112'-6154'
11/10/1997
Texaco
Well SWD#2, 7195'-7296'
11/14/1997
Texaco

Well D-1
03/04/1994
River Gas
Well D-3
05/01/1996
River Gas
Well D-5, 6980'
09/09/1997

Figure 3-8
Stiff Diagrams for Wells in the Navajo-Nugget Aquifer

647nava-stif2.dwg



LEGEND

A-Well D-1
03/04/1994
River Gas

B-Well D-3
05/01/1996
River Gas

C-Well SWD#1
02/15/1996
Texaco

D-Well SWD#2
11/14/1997
Texaco

E-Well SWD#1
11/10/1997
Texaco

F-Well D-5
09/09/1997

Figure 3-9
Trilinear Diagrams for Wells in the Navajo-Nugget Aquifer

647nava-tri.dwg

River near Helper has annual average flows of 110 cubic feet per second (cfs) based on 41 years of data (**Table 3–3**). Downstream from the North Area, the Price River near Wellington has average annual flows of 88 cfs, based on nine years of data. Huntington Creek's annual flow ranges from 42.4 cfs upstream of the South Area to 75.7 cfs downstream near the city of Huntington, based on four and eleven years of data, respectively. Flows in Huntington Creek are influenced by irrigation storage reservoir releases in the headwaters west of the Project Area. Reservoirs include Electric Lake, Cleveland Reservoir, Huntington Reservoir, Rolfsson and Miller's Flat Reservoirs. Similarly, Joe's Valley Reservoir influences flows on Cottonwood Creek within the Project Area. Annual average flows on Cottonwood Creek vary from 1.32 cfs upstream to 54.1 cfs downstream at Castle Dale, based on eleven years of data, which occurred at different times. Downstream of the South Area, 58 years of data have shown an annual average flow on the San Rafael near the confluence with the Green River of 144 cfs. Ferron Creek near Ferron averages 66.6 cfs annually based on 50 years of data. Millsite Reservoir is located west of the Community of Ferron, south of the South Area's boundary. The location of stream gaging stations in the vicinity of the Project Area are presented on **Plate 3–2**.

The Federal Emergency Management Agency (FEMA) has mapped floodplains exhibiting a flooding risk in Carbon County, which are shown on **Plate 3–2**. The 100-year floodplains along the Price River range in width from 100 to 1,800 feet, and average approximately 1,000 feet. Tributaries to the Price River, Miller Creek and Deadman Creek, range in width from 150 to 600 feet. Other Price River tributaries, Hayes Wash, Meads Wash, Cardinal Wash and Drunkard's Wash have 100-year floodplains ranging in width from 50 to 400 feet. FEMA has rescinded the floodplain maps in Huntington and unincorporated areas of Emery County, as there are no 100-year hazards (Gibson 1994 and Watanabe 1996).

Little data on channel cross-sections or substrates were found after contacting representatives of the BLM and Forest Service in the area. A stream inventory survey for a proposed pipeline stream crossing of Cottonwood Creek near Orangeville was conducted. The survey showed that the Cottonwood Creek in that reach is showing signs of instability (Rosgen classification type C4). A C4 stream is a meandering, gravel-dominated stream that is slightly entrenched, having a riffle/pool channel with a well-developed floodplain. The low sinuosity, determined by the survey suggested a transitional situation. This degradation of the stream probably is the result of bank disturbances and flow controls (BLM 1997b).

Channel substrates in the eastern, gently-sloping portion of the Project Area are composed of fine-grained materials derived predominantly from the Manocs shale.

3.2.3.2 Surface Water Quality

Regionally, the lowest TDS concentrations occur at higher elevations and increase significantly as the streams flow away from the mountains. The highly saline nature of the Mancos Shale, over which the streams flow in the lower elevations, is largely responsible for this change. The Utah Division of Water Quality (UDWQ) found concentrations of TDS typically range from 100 to 250 mg/L at the headwaters of streams, whereas concentrations range from 1,000 to 6,000 mg/L in the lower reaches of the streams (**Table 3–4**). TDS concentration data for the Price River for 1985 to 1995 ranged from 306 mg/L near Helper for 1985 to 1995, to 1,740 mg/L downstream of Wellington during the 1995 water year. In the South Area, TDS concentrations in Huntington Creek ranged from 212 mg/L upstream to 2,595 mg/L downstream. Cottonwood Creek TDS concentration data ranged from 212 mg/L upstream to 1,041 mg/L downstream. Ferron Creek TDS concentration averaged 812 mg/L between 1985 and 1995. The San Rafael River is typically slightly more saline than the Price River. TDS concentrations averaged 2,781 mg/L in the San Rafael River at U–24 and 2,255 mg/L between 1980 and 1997 in the San Rafael River at Chaffin Ranch.

Table 3–3
Stream Flow Discharge Data (in vicinity of Project Area)

Station	Location [Latitude/Longitude]	Data Water Year(s)	Average Flow (cfs)	Maximum (date)	Minimum (date)
USGS Station # 09313000	Price River, near Helper [39 43 08/110 51 55]	1996	127	657 (5/17/96)	7.0 (12/28/95)
		1935–69, 1980–81, 1991–96	110	9,340 (9/13/40)	0.4 (8/21/61)
USGS Station # 09314250	Price River, below Miller Creek, near Wellington [39 43 08/110 51 55]	1972–81	88.3	791.7 (10/81)	8.4 (1/78)
USGS Station # 09317997	Huntington Creek, near Huntington [39 23 07/111 05 15]	1996	95.4	548 (5/16/96)	9.4 (5/2/96)
		1979–80, 1986–96	75.7	1,680 (5/24/84)	3.0 (2/25/81)
UDWQ Storet # 493101–03	Cottonwood Creek, near Straight Canyon [39 17 10/111 16 10]	1977–88	1.32	200 (6/5/80)	0.14 (9/6/78)
UDWQ Storet # 493093–03	Cottonwood Creek, at U10 in Castle Dale [39 12 34/111 01 10]	1947–1958	54.1	1,450 (6/4/52)	0.0 (8/8/56)
USGS Station # 09326500	Ferron Creek (Upper Station), near Ferron [39 06 15/111 12 57]	1996	60.5	512 (5/15/96)	8 (1/27/96)
		1912–23, 1948–96	66.6	4,180 (8/27/52)	0 (10/19/76)
USGS Station # 09328500	San Rafael River, near Green River [38 51 30/110 22 10]	1996	91.3	753 (6/12/96)	11 (9/8/96)
		1910–18, 1946–96	144	12,000 (9/2/09)	0 (various years)
USGS Station # 09315000	Green River, at Green River [38 59 10/110 09 02]	1996	6281	24,000 (5/22/96)	2,070 (9/5/96)
		1906–1996	6192	68,100 (6/27/17)	255 (11/26/31)

Source: USGS 1997, UDWQ 1997, Hood and Patterson 1984.

Surface water quality monitoring stations in the vicinity of the Project Area are presented on **Plate 3–2** and **Table 3–4**.

Water type also changes with elevation. Streams in the higher elevation of the Wasatch Plateau are typically calcium bicarbonate type waters (i.e., the primary dissolved constituents are calcium and bicarbonate). As the streams flow across the Mancos Shale lowlands, both as natural flow and as irrigation return flow from highly locally saline soils, they change to sodium-sulfate type waters (**Figures 3–10, 3–11** and **3–12**). The waters are alkaline and have high levels of hardness.

Long-term total suspended solids (TSS) data from sites on the Green River, San Rafael River and Cottonwood Creek are very high and could pose limitations for aquatic life. Concentrations reflect the highly erosive nature of the shale deposits through which the rivers flow.

Table 3–4
Surface Water Quality Data (in vicinity of Project Area)

Location	Data Years	Average TDS (mg/L)
Price River at Helper	1985–95	306
Price River above Wellington	1985	323
	1994–95	287
Price River below Wellington	1985	987
	1994–95	1,740
Huntington Creek above Trail Canyon Creek	1978–82	212
Huntington Creek at Huntington	1985–95	2,595
Cottonwood Creek below Straight Canyon	1974–79	212
Cottonwood Creek at U–10	1985–95	1,041
Ferron Creek at U–10	1985–95	812
San Rafael River at Chaffin Ranch	1980–97	2,255
San Rafael River at U–24	1977–82	2,781

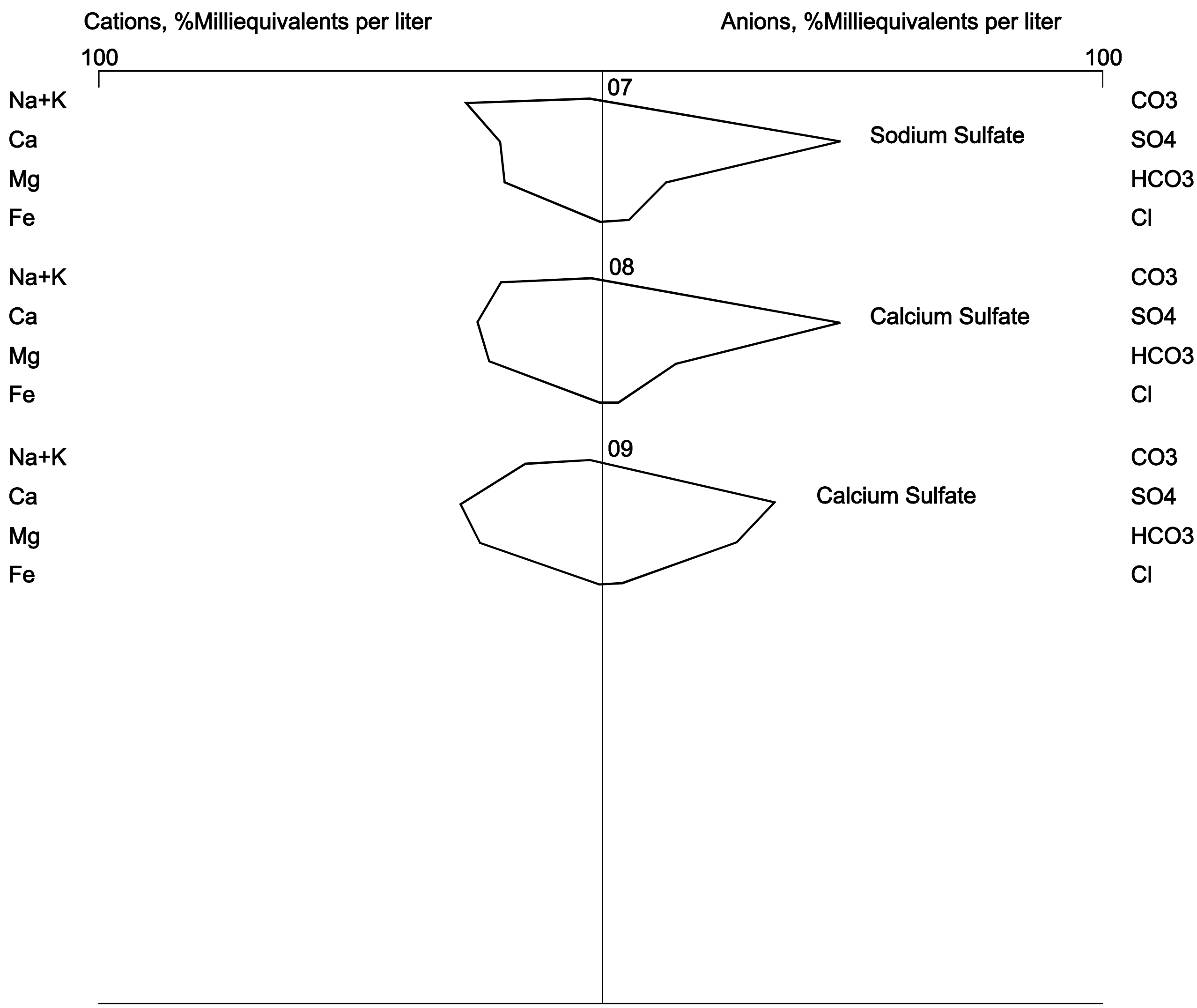
Source: UDWQ 1997

Table 3–5 summarizes water quality data for various STORET sites. For the site specific period of record, averages for flow, specific conductance, total suspended solids (TSS), TDS and total hardness are provided when available. In addition, the use classes for various sites are provided and defined.

The quality of water in the Price River and San Rafael River is protected for designated uses in accordance with the Utah water quality standards (UDWQ 1994). The Price River and its tributaries from its headwaters to Castle Gate are designated as Class 1C (protected for domestic purposes with prior treatment), Class 3A (protected for cold water species), and Class 4 (protected for agricultural uses). The Price River and tributaries are designated as Class 3C (protected for nongame fish and other aquatic life) and Class 4, from Castle Gate below the intake of the Price City wastewater treatment plant to its confluence with the Green River. The 1996 305B Report (UDWQ 1996) identifies TDS as limiting full support of agriculture along the Price River due to agriculture impacts and natural sources.

The San Rafael River and Huntington Creek are designated as Class 2B (protected non-contact recreation for boating, water skiing, and similar uses, excluding swimming), Class 3C, and Class 4. All of Cottonwood Creek is designated Class 2B and Class 4. In addition, the upper reaches below Straight Canyon are also designated 1C and 3A and Cottonwood Creek below Castle Dale Lagoons is also designated Class 3C. Reaches designated as Class 4 within the South Study Area are not fully supporting of agricultural uses due to elevated levels of TDS (UDWQ 1996).

Salinity standards have been adopted by the states of the Colorado River Basin for different locations on the Colorado River. In part, these standards were set to protect water quality in the Colorado River from increased salinity due to return flow from agricultural lands. In essence, there can be no increase in salinity of waters flowing into the Colorado River. These standards apply to the Green River and to its tributaries.



LEGEND

07 DOWNSTREAM
STORET 49323003
01/07/81

08 MIDSTREAM
STORET 49324803
01/06/81

09 UPSTREAM
STORET 493255
01/07/81

Figure 3-10
Stiff Diagrams for Sites on the Price River

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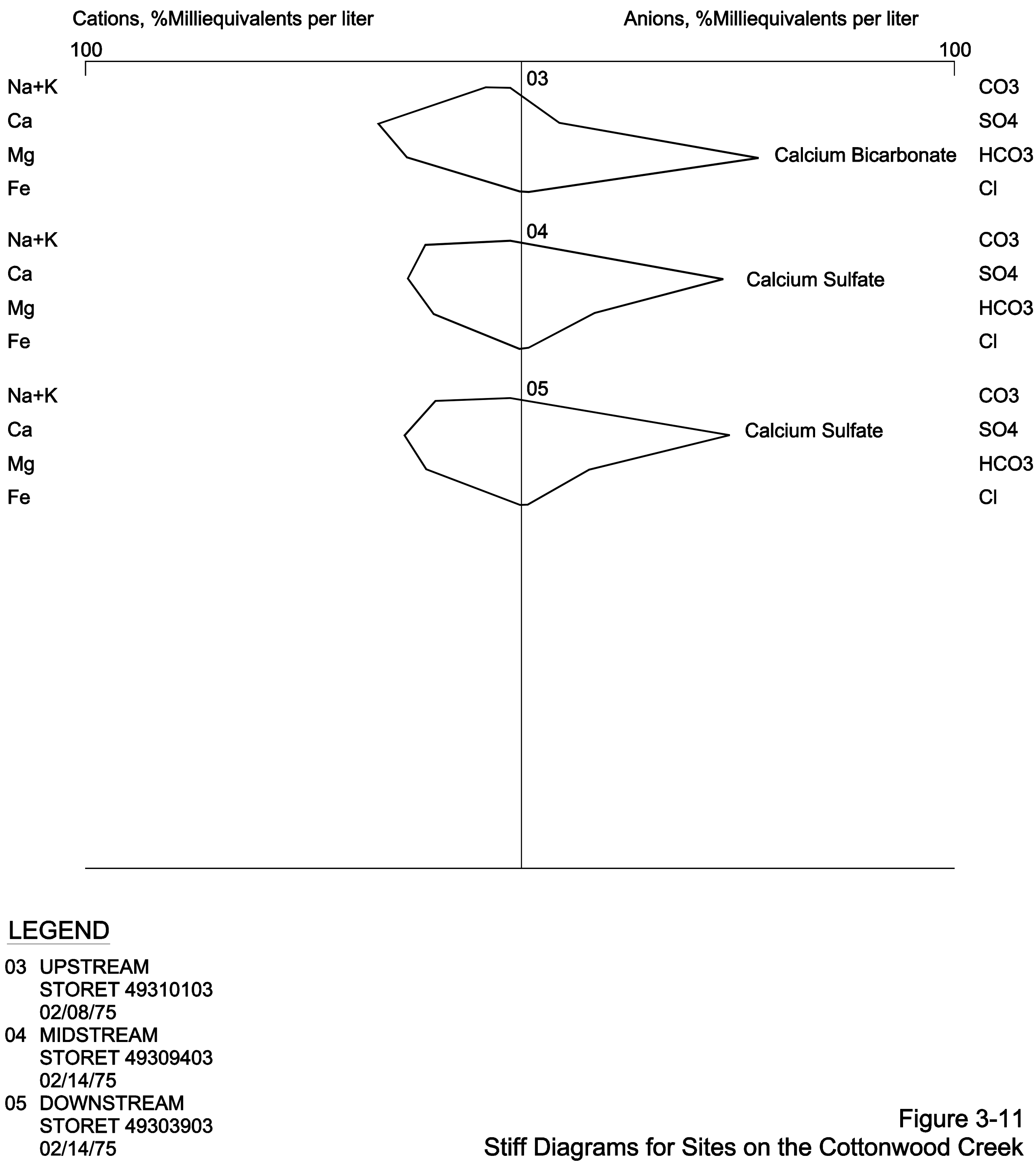
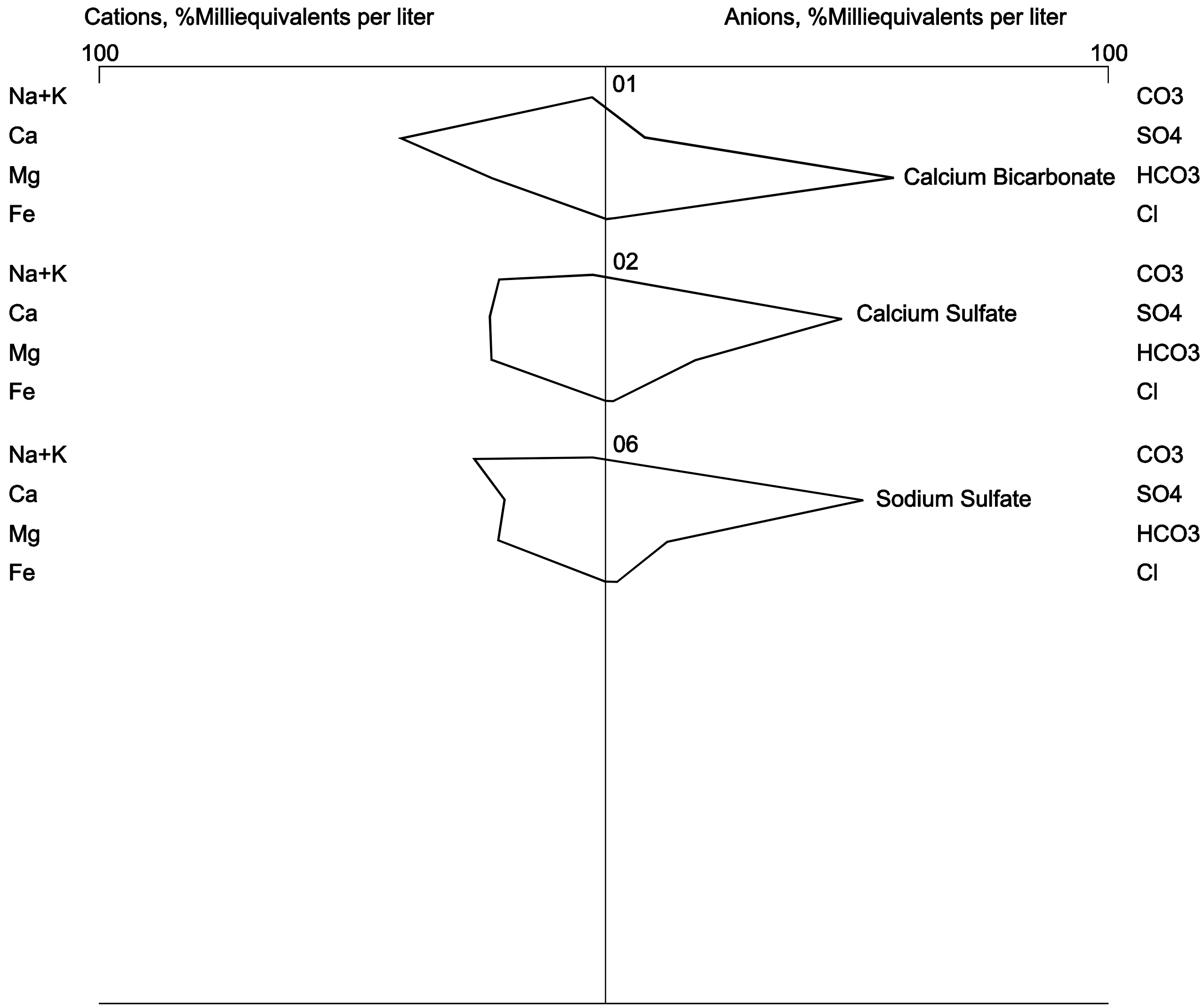


Figure 3-11
Stiff Diagrams for Sites on the Cottonwood Creek

647345.dwg



LEGEND

01 HUNTINGTON CREEK UPSTREAM
STORET 49305903
02/14/79

02 HUNTINGTON CREEK DOWNSTREAM
STORET 49305203
03/23/83

06 SAN RAFAEL AT CHAFFIN RANCH
STORET 49302703
02/08/83

Figure 3-12
Stiff Diagrams for Sites on the
Huntington Creek and the San Rafael River

647126.dwg

Table 3–5
Water Quality Data (Various Storet Sites)

Storet	Sample Point [Period of Record]	F-Average Specific Conductance (umhos/cm) [# of samples]	L-Average Specific Conductance (umhos/cm) [# of samples]	Average Flow (cfs) [# of samples]	Average TSS (mg/L) [# of samples]	Average Total Hardness (mg/L) [# of samples]	Average TDS (mg/L) [# of samples]	Location Latitude	Location Longitude	Use Classes[1]
493001-03	**GREEN R AB CNFL/ COLORADO RIVER**	**730**	**714**	**8828.1**	**716.37**	**248**	**477**	**38 11 25**	**109 53 21**	**1C 2B 3B 4**
	[5/83-8/97]	[43]	[52]	[16]	[51]	[52]	[52]			
493027-03	**SAN RAFAEL R AT CHAFFIN RANCH**	**2547**	**2591**	**138.1**	**1867.42**	**973.5**	**2255**	**38 45 32**	**110 08 24**	**2B 3C 4**
	[6/80-6/97]	[124]	[127]	[87]	[127]	[126]	[127]			
493029-03	**SAN RAFAEL R AT U24 XING**	**2671**	**3145**	**No Data**	**1034.72**	**1161.9**	**2781**	**38 51 23**	**110 22 13**	**2B 3C 4**
	[8/77-6/82]	[48]	[65]	[-]	[47]	[62]	[65]			
493047-07	**DEER CK MINE 001 SED POND OUTFALL**	**2851**	**NA[2]**	**<0.2**	**<15.59**	**NA**	**2034**	**39 21 36**	**111 06 35**	**-**
	[10/90-8/97]	[43]	[-]	[10]	[44]	[-]	[44]			
493048-07	**DEER CK MINE 002 OUTFALL**	**838**	**NA**	**10.4**	**<18.00**	**NA**	**558**	**39 21 28**	**111 06 56**	**-**
	[2/91-11/93]	[18]	[-]	[3]	[19]	[-]	[19]			
493050-03	**HUNTINGTON CK BL HUNTINGTON LAGOONS OUTFALL**	**3022**	**2870**	**6.4**	**<43.89**	**1200**	**3462**	**39 18 20**	**110 55 11**	**2B 3C 4**
	[12/78-9/97]	[23]	[2]	[22]	[9]	[2]	[5]			
493051-07	**HUNTINGTON LAGOONS OUTFALL**	**3608**	**3748**	**0.7**	**<8.92**	**1960**	**3294**	**39 18 46**	**110 55 15**	**-**
	[10/97-9/97]	[55]	[14]	[6]	[72]	[2]	[41]			
	INFLUENT	2753	3246	NA	88.63	1166.1	2579			
	[6/87-7/87]	[3]	[9]	[-]	[8]	[4]	[9]			
	CELL #1	3420	3398	NA	24.5	1283.1	2825			
	[6/87-7/87]	[4]	[8]	[-]	[8]	[4]	[8]			
	CELL #2	3485	3404	NA	13.38	1357.1	2845			
	[6/87-7/87]	[4]	[8]	[-]	[8]	[4]	[8]			
	CELL #3	3247	3448	NA	34.83	1321.6	2888			
	[6/87-7/87]	[3]	[6]	[-]	[6]	[4]	[6]			
493052-03	**HUNTINGTON CK AB HUNTINGTON LAGOONS OUTFALL**	**2429**	**2582**	**17.9**	**<128.02**	**1605.9**	**2368**	**39 18 58**	**110 55 22**	**2B 3C 4**
	[10/78-7/97]	[115]	[93]	[99]	[101]	[93]	[97]			

Table 3–5 (continued)
Water Quality Data (Various Storet Sites)

Storet	Sample Point [Period of Record]	F-Average Specific Conductance (umhos/cm) [# of samples]	L-Average Specific Conductance (umhos/cm) [# of samples]	Average Flow (cfs) [# of samples]	Average TSS (mg/L) [# of samples]	Average Total Hardness (mg/L) [# of samples]	Average TDS (mg/L) [# of samples]	Location Latitude	Location Longitude	Use Classes[1]
493057-07	**COOP MINE WATER DISCHARGE 004 TO BEAR CK**	**659**	**NA**	**1.8**	**<7.11**	**NA**	**357**	**39 24 40**	**111 05 30**	**-**
	[11/93-8/97]	[14]	[-]	[2]	[14]	[-]	[14]			
493058-03	**TRAIL CANYON CK AB CNFL/ HUNTINGTON CK**	**684**	**720**	**0.4**	**<1045.4**	**369.4**	**431**	**39 24 55**	**111 07 02**	**2B 3C 4**
	[10/78-6/82]	[14]	[11]	[5]	[10]	[10]	[14]			
493059-03	**HUNTINGTON CK AB CNFL/TRAIL CANYON CK**	**325**	**366**	**42.4**	**43.1**	**195.8**	**212**	**39 24 54**	**111 07 11**	**2B 3C 4**
	[10/78-6/82]	[15]	[12]	[3]	[10]	[12]	[14]			
493064-03	**TRAIL CANYON CK AB CO-OP MINE**	**NA**	**NA**	**NA**	**268**	**NA**	**536**	**39 25 16**	**111 07 04**	**2B 3C 4**
	[2/79]	[-]	[-]	[-]	[1]	[-]	[1]			
493071-07	**WILBERG MINE WATER OUTFALL 001**	**1019**	**854**	**<3.0**	**<7.48**	**359.2**	**680**	**39 19 23**	**111 06 50**	**-**
	[8/76-8/21]	[58]	[8]	[13]	[62]	[5]	[65]			
493073-07	**WILBERG SURFACE POND DISCHARGE 003**	**3027**	**NA**	**NA**	**<36.33**	**NA**	**1894**	**39 19 09**	**111 07 14**	**-**
	[12/82-8/97]	[28]	[-]	[-]	[29]	[-]	[29]			
493077-03	**HUNTINGTON CK BL CNFL/L FK HUNTINGTON CK**	**NA**	**281**	**NA**	**26**	**152.5**	**160**	**39 30 02**	**111 09 30**	**1C 2B 3A 4**
	[7/94]	[-]	[1]	[-]	[1]	[1]	[1]			
493078-03	**L FK HUNTINGTON CK AB CNFL/ HUNTINGTON CK**	**NA**	**271**	**32.7**	**15**	**152.5**	**150**	**39 29 59**	**111 09 32**	**1C 2B 3A 4**
	[7/94]	[-]	[1]	[1]	[1]	[1]	[1]			
493079-03	**NUCK WOODWARD CK 1.5 MI AB CNFL/ HUNTINGTON CK**	**NA**	**303**	**0.1**	**3**	**167.5**	**184**	**39 32 17**	**111 07 51**	**1C 2B 3A 4**
	[7/94]	[-]	[1]	[1]	[1]	[1]	[1]			

Table 3–5 (continued)
Water Quality Data (Various Storet Sites)

Storet	Sample Point [Period of Record]	F-Average Specific Conductance (umhos/cm) [# of samples]	L-Average Specific Conductance (umhos/cm) [# of samples]	Average Flow (cfs) [# of samples]	Average TSS (mg/L) [# of samples]	Average Total Hardness (mg/L) [# of samples]	Average TDS (mg/L) [# of samples]	Location		Use Classes[1]
								Latitude	Longitude	
493088-03	**COTTONWOOD CK BL CASTLE DALE LAGOONS EFFLUENT**	**1816**	**NA**	**12**	**10**	**NA**	**NA**	**39 10 20**	**110 56 11**	**2B 3C 4**
	[8/93-7/97]	[18]	[-]	[18]	[1]	[-]	[-]			
493090-07	**CASTLE DALE LAGOONS OUTFALL**	**2053**	**NA**	**1.9**	**<7.63**	**NA**	**1710**	**39 11 30**	**111 00 30**	**-**
	[1/92-8/97]	[32]	[-]	[6]	[33]	[-]	[32]			
493093-03	**COTTONWOOD CK AT U10 XING IN CASTLE DALE**	**1389**	**1258**	**55.9**	**<125.66**	**569.8**	**982**	**39 12 34**	**111 01 10**	**2B 4**
	[2/79-7/97]	[124]	[104]	[8]	[100]	[104]	[105]			
493094-03	**COTTONWOOD CK AT U57 XING AB CASTLEDALE**	**1044**	**1035**	**2**	**71**	**475.2**	**957**	**39 13 53**	**111 03 08**	**2B 4**
	[2/79-6/80]	[5]	[5]	[1]	[4]	[5]	[6]			
493100-03	**STRAIGHT CYN CK AT USFS BNDY AB CNFL/COTTONWOOD CK**	**NA**	**381**	**297.8**	**<8.67**	**195.3**	**201**	**39 16 15**	**111 11 14**	**1C 2B 3A 4**
	[6/95-10/95]	[-]	[3]	[3]	[3]	[3]	[3]			
493101-03	**COTTONWOOD CK 0.1 MI BL STRAIGHT CN BL JOES VALLEY RES**	**313**	**425**	**166**	**5**	**208.5**	**212**	**39 17 10**	**111 16 10**	**1C 2B 3A 4**
	[12/74-9/79]	[4]	[12]	[2]	[2]	[11]	[5]			

Notes:
1. Use Classes: 1C – Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Department of Health.
 2B – Protected for boating, water skiing, and similar uses, excluding recreational bathing (swimming).
 3A – Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
 3B – Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.
 3C – Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.
 4 – Protected for agricultural uses including irrigation of crops and stockwatering.
2. NA = Not Available

Sources: UDWQ 1997, Utah Bureau of Water Pollution Control 1990.

Current soil loss and soil salinity characteristics of the proposed disturbance areas were modeled. Projected disturbance areas were coupled with GIS information of soil erodibility and salinity characteristics to calculate soil loss using the Revised Universal Soil Loss Equation (RUSLE). Downgradient sediment delivery was estimated to be 40 percent of sediment loss. Soil loss averaged 0.4 and 0.7 tons/acre/year in the North and South areas, respectively and sediment delivery ranged between 0.2 and 0.3 tons/acre/year in the North and South areas, respectively.

Salt delivery calculations utilized sediment delivery results and salinity data from the NRCS. Salt delivery on undisturbed soils was less than 0.02 tons of salt per year on both areas. Additional details about the modeling can be reviewed in **Appendix E**.

3.2.3.3 Water Use

The Utah State Division of Water Resources analyzed water budgets on the Price River and San Rafael basins in 1975 and 1979. The results are summarized in **Table 3–6**. The results reflect analyses of the Price River watershed from north of Helper to Woodside, Utah, and analyses of the San Rafael watershed from the west end of the South Area to the San Rafael River near Castle Dale. Inflows to the watershed consist of river flows, drainage imports from other basins, and precipitation. Depletions consist of irrigation, domestic and industrial uses, and wetland storage. Wetland and alluvial storage is responsible for more than 50 percent of the depletions in this reach of the Price River. Irrigation is the next most dominant use and

Table 3–6
Division of Water Resources Water Balance Summary

Project Area Drainage			
Water Supply Source	**Annual Supply (acft/yr)**	**Water Supply Source**	**Annual Supply (acft/yr)**
INFLOWS			
Price River @ Helper (North Area)	75,742	Cottonwood, Huntington & Ferron (South Area)	129,800
Drainage Imports			
Canals	25,383		5,078
Domestic Lines	2,388		
Power Plant			7,000
Tributary Inflow	39,086		2,780
Precipitation			
Cropland	19,490		11,472
Wetland	10,594		2,330
Total Inflows	**142,599**		**125,560**
DEPLETIONS			
Irrigation	27,551		47,478
Domestic & Industrial	7,283		29,322[2]
Wetlands	42,925		8,250
River Outflow Price River @ Woodside	**75,434**	San Rafael River near Castle Dale	**58,180**

Sources: Utah Division of Water Resources 1975 and 1979, Humphry 1999 domestic and industrial uses are a distant third. The San Rafael River watershed has a different use pattern. Irrigation is the dominant water use in this reach, followed by domestic and industrial uses and wetland storage.

Water supply information for Carbon and Emery counties is provided in **Table 3–7**. For each water system, the population, calculated peak demand, and use are provided. When available, the source type and associated yields for each water system is provided. Surface water supplies, springs and wells are used to provide water for the municipalities. All large municipalities within the Project area use surface water or spring water for their water supplies except Helper, which utilizes a well.

Irrigation and industrial water use for Cottonwood and Huntington Creek for 1984, 1991 and 1996, are provided in **Table 3–8**. Irrigation use has varied between 37 and 56 million gallons per day (mgpd) for Cottonwood Creek, and between 46 and 77 mgpd for Huntington Creek. Industrial use has ranged from 5 to 10 mgpd for Cottonwood Creek and 8 to 11 mgpd for Huntington Creek. The 1996 culinary and secondary water use within communities in Emery County is shown in **Table 3–9**. Culinary water use ranged from 0.19 to 0.52 mgpd, while secondary water use ranged from 0.19 to 1.1 mgpd.

Water rights in the State of Utah are administered by the Utah Division of Water Rights. It is the authority of this agency to decide whether a water right application or an application to change an existing water right will be approved based on state laws and statutes, including those of the proposed project.

A water rights search was conducted for the Project Area. The water rights search reported 290 points of diversion of surface water sources. A total of 5,279.821 cfs and 1,341,588.09 acre feet have been adjudicated. The adjudication of water does not necessarily mean that all of the water is available every year for beneficial use, but reflects legal filings on the water. Water uses are specified as domestic, municipal, irrigation, stockwatering, mining, or mixed use. More than 88 percent of the adjudications are for irrigation in the Project Area. The water rights search identified springs at 16 different locations.

3.3 AIR QUALITY

Air quality within a region is affected by the distribution and quantity of air pollutant emission sources, the meteorology, and the topography of a region. The number, type, and spatial distribution of emission sources determine the quantity of pollutants emitted to the ambient air. The meteorology (wind and temperature) of the region affects how the pollutants will be dispersed horizontally and vertically to reduce ground levels ambient air concentrations of pollutants.

3.3.1 Climate

Annual precipitation and temperature records exist for Price, Castle Dale, and Hiawatha near the Project Area (Western Regional Climate Center [WRCC] 1997). Price is adjacent to the North Area, Castle Dale is just east of the South Area, and Hiawatha is located approximately 10 miles northwest of the South Area at an elevation about 1,600 feet higher than Price and Castle Dale. Therefore, the Price data are representative of the North Area, the Castle Dale data are representative of the lower elevations in the eastern portion of the South Area, and the Hiawatha data are representative of the higher elevations in the western portion of the South Area.

Table 3–7
Water Supply Information (Various Water System Sites)

Water System #	Name	Population	Calculated Peak Demand (MGPD[1])	Use	Unit #	Source Type	Source Name	Yield (GPM[1])	Source Location	
									Latitude	Longitude
CARBON COUNTY										
04001	Aspen View-Schofield Mt Hm	270	0.012	Residential	01	Spring	Andrew Dairy	2	-	-
					02	Spring	Tucker Canyon	5	-	-
					03	Well	Frandsen Well	30	-	-
04002	Carbonville	100	0.08	Residential	01	Wholesale	Price River WID	-	-	-
04003	Clear Creek Utilities Inc.	11	NA	Residential	01	Spring	No. 1 Upper	90	-	-
					02	Spring	No. 2 Middle	-	-	-
					03	Spring	No. 3 Lower	-	-	-
04004	Helper	3,800	1.656	Residential/ Commercial	01	Spring	Spring Canyon	290	39 51 18.0	111 05 11.0
					02	Spring	Fish Creek	50	39 46 44.0	111 02 44.0
					03	Well (deep)	UP&L	325	39 50 54.0	111 01 00.0
04007	Price City	9,407	5.000	Residential/ Commercial	01	Spring	Colton	750	39 50 02.0	111 00 30.0
					02	Spring	Upper Colton	750	39 49 45.0	110 00 22.0
					04	River	Price River	1,000	39 44 48.0	110 52 46.0
04008	Schofield	200	0.1536	Residential	01	Spring	Green Canyon	22	39 41 48.5	111 10 30.0
04009	South Price	400	0.184	Residential/ Industrial	01	Wholesale	From PRWID	-	-	-
04010	Spring Glen	545	0.293	Residential	01	Wholesale	Price River IMP	-	-	-
04011	Wellington	2,200	0.436	Residential	01	Wholesale	Price River WID	-	-	+-
04012	East Carbon City	2,000	1.1584	Residential	02	Reservoir	Grassy Trail Reservoir	-	39 37 18.0	110 22 50.0
					06	Well (deep)	SRS Mine Well	-	-	-
					07	Well (deep)	90-1 Well	21	-	-
04013	East Carbonville Water Co	25	NA	Residential	01	Wholesale	Price River WID	-	-	-
04016	Sunnyside Town Water Sys	339	0.32	Residential	01	Reservoir	Grassy Trail	-	39 37 18.0	110 22 50.0
					03	Well (deep)	90-1 Well	21	-	-
04018	Plateau Mine Water System	222	0.012672	Industrial	01	Wholesale	PRWID (Hauled)	-	-	-
					02	Spring	Star Point 1&2	1	-	-
04020	Price River Water Imp Dist	7,500	4.000	Residential	01	Stream	Price River	2,780	39 45 02.0	110 53 01.0
04023	Schofield Camp Site	160	NA	Residential	01	Well (shallow)	Camp Site Well	30	-	-
04025	Clear Creek Camp - Alpine	1,750,130	NA	Industrial	01	Well (deep)	Alpine School Well	50	-	-
04028	Perry's Boat Camp	50	NA	Resorts/ Recreation	01	Wholesale	Schofield	-	-	-

Table 3–7 (continued)
Water Supply Information (Various Water System Sites)

Water System #	Name	Population	Calculated Peak Demand (MGPD[1])	Use	Unit #	Source Type	Source Name	Yield (GPM[1])	Source Location: Latitude	Source Location: Longitude
CARBON COUNTY (continued)										
04029	Schofield Lake State Park	100	NA	Parks & Recreation	01	Well	#1 Well	-	-	-
04031	Bacon Rine Ridge Water Co	40	NA	Residential	01	Wholesale	Price WID	-	-	-
04038	Valley Camp Coal	25	NA	Non-trans., Non-community	01	Well	Alpine School Well	-	-	-
04040	Skyline Min	230	0.01	Non-trans., Non-community	01	Well (deep)	Well #1	90	-	-
04049	Madsen Bay Campground	36	NA	Resorts/ Recreation	01	Well (deep)	Madsen Bay	55	-	-
EMERY COUNTY										
08001	Castle Dale	1,800	0.496	Residential/ Commercial	01	Canal	Mammoth-Cot. Creek	75	39 13 53.0	111 01 15.0
08002	Clawson	227	0.04	Residential	01	Wholesale	Ferron WTP	50	-	-
08003	Emery	370	0.272	Residential	02	Canal	Muddy Creek	-	-	-
08004	Ferron	1,900	0.4	Residential	01	Reservoir	Millsite-Ferron Creek	222	39 05 58.0	111 11 17.0
08005	Green River	1,100	0.75	Residential/ Commercial	01	River	Green River WTP	569	38 59 18.0	110 08 53.0
08006	Huntington	2,200	0.7128	Residential/ Commercial	01	Spring	Big Bear Canyon	158	39 24 15.0	111 06 03.0
					02	Spring	Little Bear Canyon	225	39 26 38.0	111 08 35.0
					04	Spring	Tie Fork Spring	-	39 28 17.0	111 06 52.0
08007	North Emery Water Users Assoc.	1,500	NA	Residential	01	Spring	Rilda North	260	39 24 12.0	111 09 07.0
					02	Spring	Rilda Side Canyon	30	39 24 01.0	111 09 06.0
					03	Spring	Rilda Canyon South	30	39 24 08.0	111 09 02.0
					04	Spring	North	30	39 24 19.0	111 07 05.0
					05	Spring	Middle Spring	25	39 24 16.0	111 07 00.0
					06	Spring	South	80	39 24 10.0	111 06 50.0
					07	Spring	Birch (Gate/EA)	60	39 24 18.0	111 06 43.0
08008	Orangeville	1,400	0.448	Residential	01	Canal	Cottonwood Creek	-	39 14 28.0	111 03 19.0
08013	Indian Creek Campground	242	NA	USFS Campground	01	Spring	Spring	-	39 26 22.0	111 14 33.0
08014	Joes Valley Campground and Admin. Site	400	NA	Residential/ FS Campground	01	Spring	Spring	-	39 17 43.0	111 17 43.0
08016	Old Folks Flat Campground	150	NA	FS Campground	01	Spring	Spring	50	39 33 10.0	111 09 25.0

Table 3–7 (continued)
Water Supply Information (Various Water System Sites)

Water System #	Name	Population	Calculated Peak Demand (MGPD[1])	Use	Unit #	Source Type	Source Name	Yield (GPM[1])	Source Location: Latitude	Source Location: Longitude
EMERY COUNTY (continued)										
08020	Fillmore Subdivision (Joes Valley)	100	NA	Residential	01	Well (deep)	Well	-	-	-
08023	Joes Valley Resort	100	NA	Residential/ Commercial	01	Well	New Well	3	39 20 00.0	111 17 00.0
					02	Spring	-	-	39 20 00.0	111 17 00.0
08024	Goblin Valley State Park	25	NA	Residential/ Parks & Rec.	01	Well (deep)	830 Ft Well	-	-	-
08025	Cleveland Lloyd Dino Quar	25	NA	Residential/ Park & Rec.	01	Wholesale	Haul from Price	-	-	-
08030	Deer Creek Mine	330	NA	Industrial	01	Stream	WTP	35	-	-
08031	Cottonwood/Wilberg Mine	350	0.015	Commercial	01	Surface	WTP	22	-	-
08034	U.P.L. Huntington Canyon	230	NA	Residential	01	Well (shallow)	Huntington Well	211	-	-
08039	Cleveland	550	0.31968	Residential	01	Wholesale	Huntington	-	-	-
08040	Elmo	310	0.1904	Residential	01	Wholesale	Huntington	-	-	-
08041	Bear Canyon Mine	30	NA	Industrial	01	Tunnel	Old Mine (Trail)	20	-	-

Note:
1. GPM = gallons per minute

Source: Utah Division of Drinking Water 1993.

Table 3–8
Water Use — Cottonwood Creek and Huntington Creek

	Water Used During[1]		
	1984 (MGPD)	1991 (MGPD)	1996 (MGPD)
Cottonwood Creek			
Irrigation	56.10	36.61	54.56
Industrial (Pacificorp)	6.02	5.25	9.54
Huntington Creek			
Irrigation	76.62	46.28	62.57
Industrial (Pacificorp)	7.53	9.28	10.82
North Emery Water Users Association	0.19	0.14	0.19

Note:
1. MGPD = millions of gallons per day.
Source: Page 1997.

As shown on **Table 3–10**, the lower elevations receive less than 10 inches of precipitation annually. Higher elevations in the western portions get approximately 13.5 inches annually. Snow amounts also are low east of the Wasatch Mountains. Price receives 24 inches of snow annually and Castle Dale experiences about 16 inches, while Hiawatha gets about 63 inches. Average high temperatures in the Project Area range from 90°F in July to 35°F in January. Average minimum temperatures range from 7°F in January to 58°F in July.

Meteorological data collected during 1986 at Utah Power and Light's Clawson Power Plant are the closest to the Project Area. As shown on the wind frequency distribution chart (**Figure 3–13**), the predominant wind direction is from the west. The combined frequency when the wind blows from the west and west-northwest is nearly 15 percent. The average amount of time that the wind blows from any of the other 14 directions

Table 3–9
Culinary and Secondary Water Usage, Emery County Communities 1996

Community	Total Culinary Water Usage (million gallons per day)	Total Secondary Water Usage (million gallons per day)
Castle Dale	0.381	0.836
Emery	0.524	0.190
Ferron		1.063
Clawson	0.429	0.107
Orangeville	0.229	0.761
Huntington	0.274	0.936
Cleveland		0.578
Elmo	0.191	0.383

Source: Leamaster 1997.

Table 3–10
Climatology of Ferron Project Area

	Price				Castle Dale				Hiawatha			
Month	**Average Max Temp (°F)**	**Average Min Temp (°F)**	**Avg. Precip (in.)**	**Avg. Snow (in.)**	**Avg. Max Temp (°F)**	**Avg. Min Temp (°F)**	**Avg. Precip (in.)**	**Avg. Snow (in.)**	**Avg. Max Temp (°F)**	**Avg. Min Temp (°F)**	**Avg. Precip (in.)**	**Avg. Snow (in.)**
JAN	36.7	13.3	0.86	9.4	34.4	7.4	0.58	6.2	32.5	13.6	0.97	14.8
FEB	43.2	20.2	0.76	4.6	42.1	14.9	0.48	3.1	36.7	17.6	1.02	13.1
MAR	52.8	27.8	0.82	1.2	52.7	23.9	0.54	1.2	43.8	22.9	1.13	10.0
APR	63.0	34.4	0.53	0.2	62.3	30.9	0.48	0.4	54.6	31.3	0.94	2.9
MAY	72.5	43.0	0.81		72.2	39.0	0.70	0.1	64.1	39.5	1.19	1.6
JUN	83.8	51.9	0.64		82.9	47.0	0.48		74.8	48.5	0.96	
JUL	90.1	58.3	0.90		88.6	53.4	0.81		81.5	55.8	1.30	
AUG	88.5	57.0	1.00		86.1	51.5	0.96		78.7	54.0	1.80	
SEP	79.4	48.1	1.07		77.7	42.4	0.85		71.0	46.4	1.34	0.2
OCT	65.5	37.5	1.26	0.3	65.3	32.0	0.77	0.2	58.7	36.2	1.22	1.0
NOV	49.5	25.6	0.64	2.7	49.3	20.6	0.47	1.0	43.2	23.7	0.84	6.6
DEC	39.8	16.4	0.54	5.8	38.0	11.7	0.50	4.0	43.6	16.3	1.01	12.7
ANN.	63.8	36.2	9.81	24.3	62.7	31.3	7.59	16.2	56.2	33.9	13.71	63.0

Source: WRCC 1997

is only four percent of the time. The strongest winds blow from the west with speeds exceeding 21 knots. However, the wind is calm about 28 percent of the time.

The Project Area is subject to prolonged and intense temperature inversions. Temperature inversions occur when the air temperature near the surface is lower than the temperature above the surface (the opposite of a normal atmospheric vertical temperature profile). The depth of the cold air defines the mixing height, i.e., the depth of the atmosphere in which pollutants are confined and not allowed to rise above the mixing height. As a result of a low mixing height and calm to light winds generally associated with inversions, prolonged inversions create a buildup of pollutants confined in a volume close to the surface. Inversions are most intense during winter when shorter daylight hours and snow cover combine to intensify the temperature difference between the surface and higher altitudes. Inversions may persist throughout the day during winter. In summer, early morning inversions are rapidly dissipated by the sunshine warming the air near the ground.

3.3.2 Existing Air Quality

National Ambient Air Quality Standards (NAAQS) have been established by the U.S. Environmental Protection Agency (EPA) and the Utah Department of Environmental Quality, Division of Air Quality (UDAQ) for six air pollutants, known as "criteria pollutants". The purpose of the NAAQS is to protect the public health, since pollutant concentrations greater than the standards are considered potentially harmful. For the FNG Project, pollutants of interest are nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO), which would be emitted from compressors, pumps, construction equipment, and vehicles

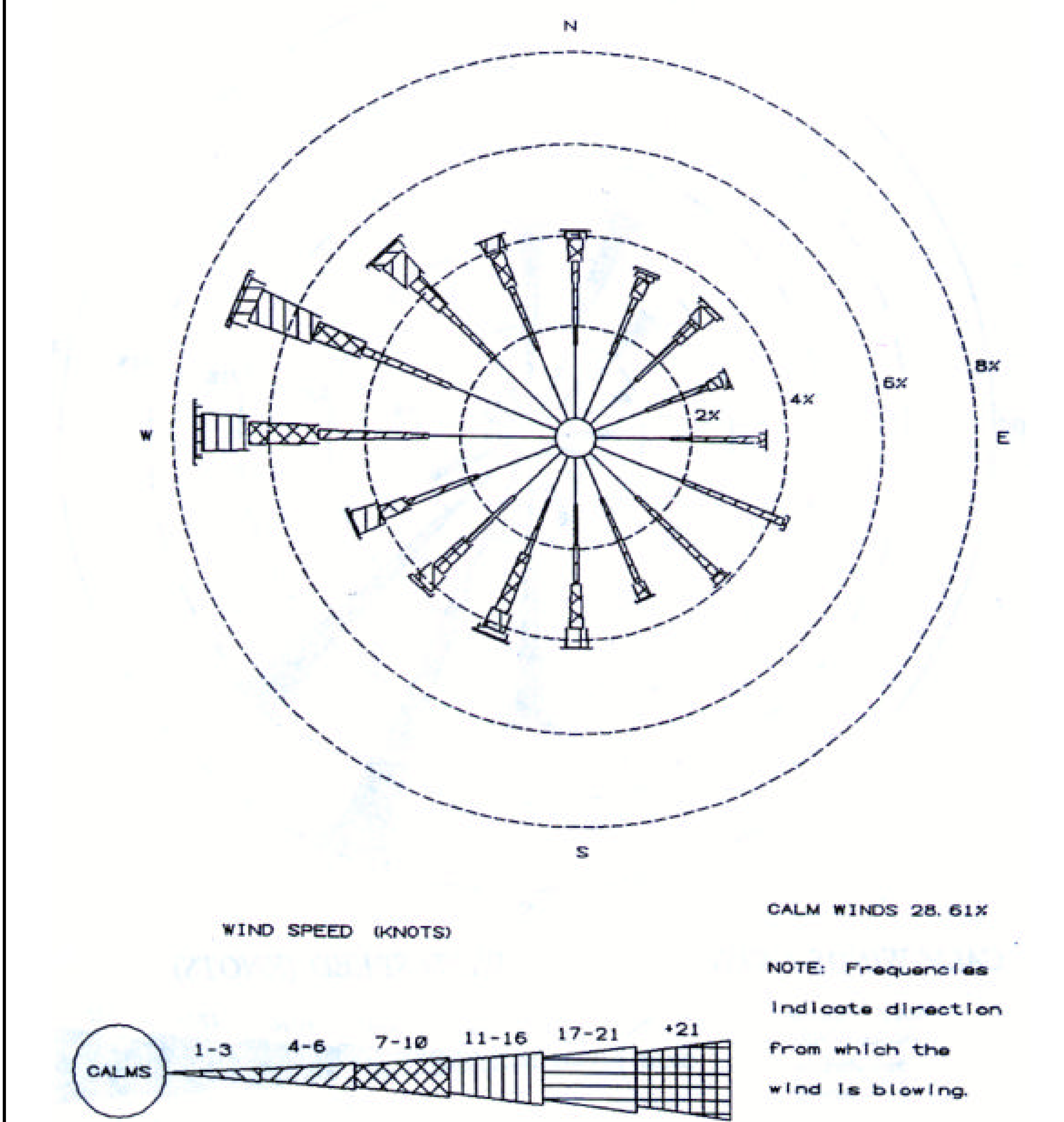


Figure 3-13
Wind Frequency Distribution
UPL Clawson, Utah
January 1 - December 31 1986

and particulate matter that would be generated by construction activities, vehicles traveling on access roads, and wind-blown dust over exposed areas, such as well pads and roads. The regulated particulate matter is PM_{10}, which is defined as suspended particles with an aerodynamic diameter of ten microns or less. The State of Utah has adopted the same standards as the NAAQS. The National and Utah standards for NO_2, CO, SO_2, and PM_{10} are shown on **Table 3–11**.

Table 3–11
National and Utah Ambient Air Quality Standards

Pollutant	Averaging Time	Concentration ($\mu g/m^3$)[2]
Carbon Monoxide	1 hour [1]	40,000
	8 hour [1]	9,000
Nitrogen Dioxide	Annual arithmetic mean	100
Sulfur Dioxide	Annual arithmetic mean	80
	24-hour	365
	3-hour	1,300
PM_{10}	Annual arithmetic mean	50
	24 hour [1]	150

Notes:
1. Concentration not to be exceeded more than one time per year in averaging time period.
2. Micrograms ($\mu g/m^3$) of pollutant per cubic meter of air at standard atmospheric conditions (pressure 29.92 inches mercury, temperature 25 °Centigrade).

The UDAQ has the responsibility to monitor air quality in Utah. Measurements are typically taken in urban areas where ambient pollution levels are expected to be the highest. As a result, no routine monitoring occurs in the project vicinity but some data has been collected (Symons 1997). PM_{10} was measured in 1994 at Sunnyside, Utah, approximately 25 miles east-southeast of Price. Monitoring indicated that the 24-hour concentrations ranged from 11 to 30 $\mu g/m^3$. The annual average concentration was 13 $\mu g/m^3$. The highest 24-hour concentration was 20 percent of the NAAQS and the annual average was 26 percent. NO_2 was measured from 1977 to 1981 at Castle Dale, Utah. Measurements indicate the annual average varied from 10 to 18 $\mu g/m^3$. The highest annual NO_2 average was only 18 percent of the NAAQS. In lieu of CO measurements in the Project Area, the UDAQ assumes the average CO background assumption to be 8,000 $\mu g/m^3$ for the one-hour averaging period and 2,000 $\mu g/m^3$ for the 8-hour averaging period.

3.3.3 Regulatory Status

Based upon the measured data, the remoteness of the region, and the lack of major urban communities, the region around Price is designated as an attainment area for all the criteria pollutants. This means that all criteria pollutants are below the designated levels of NAAQS.

Construction of facilities that would emit pollutants require review and permitting by the UDAQ. The UDAQ requires air dispersion modeling to demonstrate compliance with ambient air standards for sources with a potential to emit more than 40 tons per year of a criteria pollutant. Sources with a potential to emit more than 250 tons per year of a criteria pollutant are considered major sources and require a Prevention of Significant Deterioration pre-construction review and permit. Sources with potential emissions below 250 tons per year are subject to New Source Review permitting. These reviews may be required of natural-gas fired compressors for the FNG Project. The air quality assessment under these reviews includes an estimation of emissions, evaluation of technologies employed to reduce emissions, and an assessment of compliance with NAAQS.

The Companies would be required to apply for an Approval Order from the UDAQ before beginning any construction of an air pollution source. In addition to the permitting activities previously described, an Approval Order would also be required for construction activities greater than 0.25 acres. These activities would include construction of well pads and roads for the Ferron Project. The Approval Order for construction would include the methods to be employed to control fugitive dust associated with construction activities, such as watering, chemical treatment, etc.

3.4 SOILS

3.4.1 North Area

Soils within the North Area have developed on mesas, benches, hill slopes, toe slopes, and outwash plains. Parent materials are residuum, colluvium, alluvium, and glacial outwash, which were derived from sandstone and shale. These soils have formed on nearly level to moderately-steep slopes. They range from shallow to very deep and are well-drained. They have developed in the semi-arid to arid climatic regime of this area.

According to the Soil Survey of Carbon Area, Utah (Jensen and Borchert 1988), 21 soil mapping units are present within the boundaries of the North Area. A description of each mapping unit is found in **Table 3–12**.

Critical soils were identified using several criteria, including water and wind erosion hazards, salinity, and suitability for reclamation. If a soil has at least one of these criteria above a threshold level, it was designated a critical soil. These criteria are described below.

The Soil Survey of Carbon Area rates each soil mapping unit as having a slight, moderate, high, or very high water erosion hazard. These ratings were determined using soil erodibility and runoff factors as defined in the National Soil Survey Handbook (Natural Resource Conservation Service [NRCS] 1996). The water erosion hazard becomes a critical issue when protective vegetation is removed from a soil such as during and following road and well pad construction. For purposes of this study, soil mapping units having a high or very high water erosion hazard rating were designated "critical soils."

The Carbon Area survey also rates each mapping unit as having a none, slight, moderate, high, or very high wind erosion hazard. These ratings are based on the Wind Erodibility Index as defined in the National Soil Survey Handbook (NRCS 1996). Wind erosion is also a critical issue following removal of protective vegetation. For purposes of this study, soil mapping units having a high or very high wind erosion hazard rating were designated "critical soils."

Table 12 of the Carbon Area survey gives the electrical conductivity range of each mapping unit in mmhos cm^{-1}. The National Soil Survey Handbook (NRCS 1996) classifies conductivity ranges into five salinity classes: non-saline, very slightly saline, slightly saline, moderately saline, and strongly saline. Saline soils contain soluble salts in quantities that would tend to impair plant growth during reclamation and pose a potential water quality impact when unprotected soils are subject to erosion. For purposes of this study, soils

Table 3–12
Characteristics of North Area Soils

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil
2	Badland	steep–very steep	nearly barren areas of shale at base of Book Cliffs	Mancos Shale	variable	very high	high	variable	unsuitable	yes
3	Badland-Rubbleland-Rock outcrop complex	steep–very steep	mountain and hill slopes; base of Book Cliffs	Blackhawk Formation & Mancos Shale	variable, boulders, rock outcrop	very high	high	variable	unsuitable	yes
17	Chipeta-Badland complex	3%–very steep	Mancos Shale hills	residuum & Mancos Shale	silty clay loam & variable	very high	moderate	moderate	unsuitable (salinity >9 mmhos)	yes
33	Gerst-Badland-Rubbleland complex	15–50%	side slopes of mesas & fan terraces	residuum, colluvium, Mancos Shale	extremely stony loam, boulders & variable	high	low	non-saline	unsuitable (>35% coarse fragments)	yes
35	Gerst-Badland-Stormitt complex	10%–very steep	hill slopes	residuum, colluvium, glacial outwash, Mancos Shale	cobbly loam, gravelly sandy clay loam & variable	moderate–high	low	non-saline	unsuitable (>35% coarse fragments	yes
37	Gerst-Strych-Badland complex	50–75%	side slopes of benches	colluvium, residium, Mancos Shale	extremely stony loam, very stony loam & variable	high	low	non-saline	unsuitable (>35% coarse fragments	yes
41	Green River-Juva Variant complex	0–5%	floodplains, alluvial fans, stream terraces	alluvium	silt loam & fine sandy loam	slight	moderate	non-saline to slightly alkaline	poor	no
50	Haverdad Loam, moist	1–5%	alluvial fans & valley floors	alluvium	loam	moderate	moderate	non-saline	fair	no

Table 3–12 (continued)
Characteristics of North Area Soils

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil
65	Mivida very fine sandy loam	1–6%	benches, mesas, fan terraces	alluvium	very fine sandy loam	moderate	moderate	non-saline	poor	no
72	Pathead-Curecanti family association	50–70%	mountain slopes	colluvium	extremely stony loam & loam	high	slight–moderate	non-saline	unsuitable (>35% coarse fragments)	yes
74	Penoyer Variant loam	3–6%	alluvial fans & valley floors	alluvium	loam	moderate	moderate	non-saline	fair	no
80	Persayo-Chipeta complex	3–20%	Mancos Shale hills	residuum & alluvium	loam & silty clay loam	moderate–high	moderate	slightly–moderately saline	poor–unsuitable (salinity >9 mmhos for Chipeta)	yes
90	Ravola loam	1–3%	alluvial fans & narrow valley floors	alluvium	loam	moderate	moderate	very slightly to slightly saline	poor	no
91	Ravola loam, eroded	1–6%	alluvial fans & narrow valley floors	alluvium	loam	moderate	moderate	very slightly to slightly saline	poor	no
93	Ravola-Slickspots Complex	1–3%	alluvial fans & floodplains	alluvium	loam	moderate	moderate	very slightly to strongly saline	poor–unsuitable (slickspots strongly saline)	yes
110	Stormitt gravelly sandy clay loam	3–10%	benches	glacial outwash	gravelly sandy clay loam	slight	slight	non-saline	unsuitable (>35% coarse fragments)	yes
113	Strych very stony loam	3–15%	benches & outwash plains	glacial outwash & alluvium	very stony loam	moderate	slight	non-saline	unsuitable (>35% coarse fragments)	yes
114	Strych very stony loam, dry	3–30%	alluvial fans & terraces	alluvium & glacial outwash	very stony loam	moderate	slight	non-saline	unsuitable (>35% coarse fragments)	yes

Table 3–12 (continued)
Characteristics of North Area Soils

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil
117	Trag-Beje-Senchert Complex	3–30%	mountain slopes, side slopes next to drainages	residuum, colluvium, alluvium	clay loam & loam	slight–moderate	slight	non-saline	fair	no
120	Travessilla-Rock Outcrop Complex	3%–very steep	benches & mesas	residuum, Mancos Shale, Blackhawk Fm.	fine sandy loam & bedrock	moderate	moderate	non-saline	fair–unsuitable (rock outcrop areas)	yes (rock outcrop areas)
121	Travessilla-Rock Outcrop-Gerst Complex	40–70%	canyon sides	residuum, colluvium, Mancos Shale, Blackhawk Fm.	extremely bouldery loam, very channery loam, bedrock	high	slight	non-saline	unsuitable (>35% coarse fragments)	yes

Haverdad loam, moist, 1 to 5 percent slopes (50)
Mivida very fine sandy loam, 1 to 6 percent slopes (65)
Penoyer Variant loam, 3 to 6 percent slopes (74)
Persayo-Chipeta complex (80)
Ravola loam, 1 to 3 percent slopes (90)
Ravola loam, 1 to 6 percent slopes, eroded (91)
Ravola-Slickspots complex (93)
Rock outcrop-Rubbleland-Travessila complex (96)
Shupert-Winetti complex (107)
Stormitt gravelly sandy clay loam, 3 to 10 percent slopes (110)
Strych very stony loam, 3 to 15 percent slopes (113)
Strych very stony loam, dry, 3 to 30 percent slopes (114)
Trag-Beje-Senchert complex (117)
Travessilla-Rock outcrop complex (120)

classified as "moderately" or "strongly saline" (average conductivity >8 mmhos cm^{-1}) were designated "critical soils."

Soil suitability for reclamation has been described in a Forest Service publication (1979). A soil is defined as "unsuitable" for reclamation if it meets any one of the following criteria:

- clay content greater than 60 percent;
- coarse fragments exceeding 35 percent of the soil by volume (i.e. a soil described as stony, channery, or cobbly);
- pH less than 4.5 or greater than 9.1; and
- salinity greater than 9 mmhos/cm^{-1}.

Soils found to be unsuitable for reclamation using these criteria were designated critical soils. **Plate 3–3** shows areas where critical soils and slopes greater than 6 percent overlap in the North Area. Using the criteria described above, approximately 10,233 acres (56 percent) of the North Area are covered by areas where critical soils occur on slopes greater than 6 percent.

3.4.2 South Area

Soil classifications were compiled using an updated soil survey conducted by the NRCS in 1997. The portions of the South Area and the pipeline corridor not covered by the NRCS were supplemented with the current Emery County Soil Survey. Characteristics of soil types are shown in **Table 3–13**. The same analysis as performed for the North Area was used to determine areas where critical soils occur on slopes greater than six percent. According to the criteria and analysis, approximately 59,029 acres (53 percent) of the South Area are critical soils on slopes greater than six percent (**Plate 3-3**).

3.5 VEGETATION

3.5.1 Regional Overview

The Project Area is located in the Canyonlands floristic section of the Intermountain region (Cronquist et al. 1972). The topographic relief of this region, and its resulting impact on precipitation, fosters a wide diversity of plant communities. Higher elevations characterizing the Wasatch Plateau to the west and north create moister, cooler environments favored by conifer forests. In contrast, Castle Valley located to the east and south of the Wasatch Plateau presents environments that are restrictive to all but the most arid, desert-like communities found in the region. Wetlands are very limited in extent, and associated with sparsely scattered seeps, ponds, and perennial streams. Riparian areas are found sporadically along perennial streams.

The composition and extent of native plant communities have been modified by the development of urban centers, agriculture, livestock grazing, and by the extraction of coal, oil and gas in the area. Urban development and agriculture have permanently eliminated portions of the native plant communities, and livestock grazing and extraction activities have altered the species composition of plant communities. These factors have influenced the establishment of noxious weeds in the area. While populations of noxious weeds are common where the native plant communities have been disturbed or removed, they do not appear to be invasive into undisturbed communities.

Table 3–13
Characteristics of South Area Soils

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil?
As	Abbott silty clay, strongly saline	1–3%	stream terraces & alluvial fans	alluvium	silty clay	moderate	moderate	strong	unsuitable (salinity >9 mmhos/cm)	yes
100, Ba, BL (2)[1]	Badland	steep–very steep	nearly barren areas of shale at base of the Wasatch Plateau	Mancos Shale	variable	very high	high	variable	unsuitable (badland)	yes
171	Badland-Chipeta-Persayo complex	30–60%	steep shale hills & side slopes of structural benches & mesas	Mancos Shale	silty clay, clay loam & variable	very severe	very severe	none–slight; variable	unsuitable (badland and salinity >9 mmhos)	yes
131	Badland-Persayo-Rock outcrop complex	35–45%	sideslopes on mesas, structural benches & cestas	Blackhawk Formation & Mancos Shale	cobbley loam & variable	very severe	slight–moderate	non-saline–slight; variable	unsuitable (badland & >35% coarse fragments)	yes
BY (3)	Badland-Rubble-land- Rock outcrop complex	steep–very steep	mountain and hill slopes; base of the Wasatch Plateau	Blackhawk Formation & Mancos Shale	variable, boulders, rock outcrop	very high	high	variable	unsuitable (badland & >35% coarse fragments)	yes
Beb	Beebe very fine sandy loam	1–3%	alluvial fans & floodplains	alluvium	very fine sandy loam	slight	moderate	slight	unsuitable (pH >9.1)	yes
BlB (8)	Billings silty clay loam	1–3%	alluvial fans, floodplains, narrow alluvial valley floors	alluvium	silty clay loam	moderate	moderate	very slight–slight	fair	no
BlC2	Billings silty clay loam	2–6%	alluvial fans	alluvium	silty clay loam	moderate	moderate	slight–moderate	unsuitable (salinity >9 mmhos/cm)	yes
BsB	Billings silty clay loam, moderately well drained	1–3%	alluvial valley floors	alluvium	silty clay loam	moderate	moderate	moderate	unsuitable (salinity >9 mmhos/cm)	yes
SNC	Bowdish-Lazear-Gerst complex	2–8%	structural benches	alluvium	channery sandy clay loam, loam, clay loam	slight–severe	slight–moderate	slight	unsuitable (>35% coarse fragments)	yes
261	Brownsto-Podo-Rock outcrop association	15–65%	mountain sideslopes & hillsides	alluvium, colluvium, residuum	very stony sandy loam, very gravelly loam	moderate	slight	slight	unsuitable (>35% rock fragments)	yes

Table 3–13 (continued)
Characteristics of South Area Soils

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil?
CeE2	Castle Valley extremely rocky very fine sandy loam, eroded	0–20%	upland benches & mesas	residuum	gravelly very fine sandy loam	slight to high	slight to high	non-saline	unsuitable (>35% rock fragments)	yes
MTH (13)	Cabba family-Guben-Rock outcrop complex	40–75%	canyon sides	colluvium & residuum	loam & very stony loam	high	none	non-saline	unsuitable (>35% rock fragments)	yes
CBF2 (17)	Chipeta-Badland complex	3%–very steep	Mancos Shale hills	residuum & Mancos Shale	silt clay loam & variable	very high	moderate	moderate	unsuitable (salinity >9 mmhos)	yes
CPB (18)	Chipeta-Persayo complex	1–3%	toe slopes	residuum & alluvium	silty clay loam	moderate	moderate	slight–moderate	unsuitable (salinity >9 mmhos)	yes
CPE2	Chipeta-Persayo Association, eroded	3–20%	Mancos Shale hills	Mancos Shale	silty clay loam and loam	high		moderate–strong	unsuitable (salinity >9 mmhos)	yes
SlB	Clifsand very fine sandy loam	1–3%	alluvial fan remnant & bench tops	alluvium	very fine sandy loam	slight	moderate	non-saline–very slight	good	no
SlD2	Clifsand fine sandy loam	3–10%	alluvial fan remnant & bench tops	alluvium	fine sandy loam	slight	moderate	non-saline–very slight	good	no
SmD2, SMD2	Clifsand-Minchey Complex	1–8%	mesas, benches & alluvial fan remnants	alluvium	gravelly sandy loam & loam	slight	slight	slight	unsuitable (>35% coarse fragments)	yes
DHG2 (20)	Comodore-Datino Varient complex	40–60%	mountain slopes & toe slopes	colluvium	very stony & extremely stony fine sandy loam	high	none	non-saline	unsuitable (>35% coarse fragments)	yes
UFF2	Doney-Cabba-Podo complex	20–60%	mountain slopes	residuum & colluvium	loam, gravelly loam, cobbley loam	moderate–severe	slight	slight	poor	yes
LYD2	Farb-Persayo Complex	3–15%	rolling sandstone & shale hills	Mancos Shale	gravelly fine sandy loam & channery loam	slight–moderate	slight–moderate	slight–moderate	unsuitable (>35% coarse fragments)	yes

Table 3–13 (continued)
Characteristics of South Area Soils

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil?
456	Farb-Sandbench-Rock outcrop association	2%–very steep	cuesta slopes & structural benches	Mancos Shale, eolian material, alluvium	loamy fine sand & gravelly sandy loam	slight	slight–high	slight	unsuitable (>35% coarse fragments	yes
Fe, Fr (31)	Ferron silt loam	0–3%	alluvial fans & alluvial valley bottoms	alluvium	silt loam	slight	none	very slight–slight	fair	no
C35 (35)	Gerst-Badland-Stormitt complex	10–60%	hills lopes	residuum, colluvium, glacial outwash	channery clay loam, gravelly sandy clay loam & variable	moderate–severe	slight	very slight–variable	unsuitable (>35% coarse fragments)	yes
555, 254, NSD	Gerst-Chupedera-Travessilla association	2–30%	cuestas & structural benches	eolium, alluvium, residuum	channery loam, fine sandy loam, gravelly fine sandy loam	moderate–severe	slight–moderate	slight	unsuitable (>35% coarse fragments)	yes
NNE2, NTF2	Gerst-Lazear-Badland complex	8–30%	rolling shale & sandstone hills	residuum, colluvium, alluvium	clay loam, loam & variable	moderate–very severe	moderate	slight	unsuitable (badland and >35% coarse fragments)	yes
NGG2, 569 (37)	Gerst-Strych-Badland complex	50–75%	side slopes of benches	colluvium, residuum, Mancos Shale	extremely stony loam, very stony loam & variable	high	low	non-saline, variable	unsuitable (>35% coarse fragments)	yes
GKC (39)	Glenberg family	1–3%	floodplains & valley floors	alluvium	very fine sandy loam & fine sandy loam	moderate	high	non-saline	fair	yes
GLC (40)	Glenberg family	3–6%	valley floors & low terraces	alluvium	very fine sandy loam & loam	moderate	moderate	non-saline	fair	no
Mx	Glenberg-Colorow-Pherson complex	0–4%	stream terraces and river floodplains	alluvium	fine sandy loam	slight	slight–moderate	slight	fair	no
TY (41)	Green River-Juva Varient complex	0–5%	floodplains, alluvial fans, stream terraces	alluvium	silt loam & fine sandy loam	slight	moderate	non-saline–slight	poor	no

Table 3–13 (continued)
Characteristics of South Area Soils

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil?
COD2, Sn	Greybull-Utaline-Persayo complex	3–55%	small mesa remnants & highly dissected alluvial fans	alluvium, colluvium	clay loam, gravelly loam, silty clay loam	moderate–very severe	slight	non-saline–slight	poor	yes
UMF2 (46)	Guben-Pathead extremely stony loams	30–50%	mountain slopes	colluvium & residuum	extremely stony loam	moderate	none	non-saline	unsuitable (>35% coarse fragments)	yes
VOH (47)	Guben-Rock outcrop complex	50–80%	mountain slopes	colluvium	extremely bouldery fine sandy loam	slight	none	non-saline	unsuitable (>35% coarse fragments)	yes
133	Hanksville-Chipeta complex	1–12%	alluvial fans, structural benches, small shale hills	alluvium & Mancos Shale	clay & silty clay	severe–very severe	moderate	strong	unsuitable (salinity >9 mmhos/cm)	yes
OCA2, C49 (49)	Haverdad loam, alkali	0–3%	fan terraces, alluvial fans, valley floors	alluvium	loam	moderate	moderate	non-saline–very slight	poor	no
ADC, HBC (52)	Hernandez family	3–8%	fan terraces	alluvium	loam	moderate	moderate	non-saline–very slight	poor	no
Hn (55)	Hunting loam	1–3%	alluvial fans & valley floors	alluvium	loam	slight	moderate	very slight–slight	fair	no
Hs (56)	Hunting loam, moderately saline	1–3%	alluvial fans & valley floors	alluvium	loam	slight	moderate	moderate	unsuitable (salinity >9 mmhos)	yes
KeE2	Kenilworth very stony sandy loam	0–20%	high benches & old dissected outwash plains	alluvium	very stony sandy loam	slight–moderate		non-saline	unsuitable (>35% coarse fragments)	yes
KlB, KpB (59)	Killpack clay loam	1–3%	Mancos Shale hills	Mancos Shale	clay loam	moderate	moderate	very slight–slight	fair	no
KmB	Killpack clay loam, somewhat poorly drained	1–3%	gently sloping shale benches	alluvium overlying residuum	clay loam	severe	moderate	moderate	unsuitable (salinity >9 mmhos)	yes

Table 3–13 (continued)
Characteristics of South Area Soils

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil?
KlC2, KpC2 (60)	Killpack clay loam	3–6%	Mancos Shale hills	Mancos Shale	clay loam	high	moderate	very slight–slight	fair	yes
NFE	Lazear-Gerst-Pinon complex	3–35%	benches & sandstone capped rolling shale hills	residuum & alluvium	gravelly loam	moderate–severe	slight	slight	unsuitable (>35% coarse fragments)	yes
NPD	Lazear-Pinon complex	2–15%	structural benches		channery fine sandy loam & gravelly loam	moderate	slight	non-saline	unsuitable (>35% coarse fragments)	yes
Lb, LS (61)	Libbings silty clay loam	0–3%	foot slopes & Mancos Shale hills	Mancos Shale	silty clay loam	moderate	moderate	strong	unsuitable (salinity >9 mmhos)	yes
HUG, DSG2 (62)	Midfork family-Comodore complex	50–70%	mountain slopes	colluvium	very channery & very stony loam	high	none	non-saline	unsuitable (>35% coarse fragments)	yes
MlB, McB (64)	Minchey loam	1–3%	benches & mesas	glacial outwash	loam	moderate	moderate	non-saline–very slight	fair	no
PdB, 224 (65)	Mivida very fine sandy loam	1–6%	benches, mesas, fan terraces	alluvium	very fine sandy loam	moderate	moderate	non-saline	poor	no
MsB	Minchey-Clifsand complex	1–3%	tops of alluvial fan remnants	alluvium	loam	slight	slight–moderate	slight	fair	no
MsC2	Minchey-Clifsand complex	2–6%	gently undulating tops of fan remnants	alluvium	sandy clay loam, gravelly loam	slight	slight	slight	poor	no
175	Minchey-Greybull-Sagers complex	2–8%	alluvial fans & structural benches	alluvium & residuum	gravelly loam & loam	moderate–severe	slight–moderate	non-saline–slight	unsuitable (>35% coarse fragments)	yes
PaB	Palisade loam, high water table variant	1–3%	low areas on benches	glacial outwash	loam	low		non-saline	good	no
PdB	Palisade very fine sandy loam	1–3%	mesas & benches	glacial outwash	very fine sandy loam	moderate		non-saline	good	no
PsC2	Penoyer very fine sandy loam, eroded	3–6%	alluvial fans near the bases of mesas	alluvium	very fine sandy loam	high		non-saline	good	yes

Table 3–13 (continued)
Characteristics of South Area Soils

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil?
PeB, PnA (73)	Penoyer Variant loam	1–3%	valley floors	alluvium	loam	slight	moderate	non-saline	fair	no
PeC2 (74)	Penoyer Variant loam	3–6%	alluvial fans & valley floors	alluvium	loam	moderate	moderate	non-saline	fair	no
PCE2 (80)	Persayo-Chipeta complex	3–20%	Mancos Shale hills	residuum & alluvium	loam & silty clay loam	moderate–high	moderate	slight–moderate	poor	no
KAC (81)	Persayo-Greybull complex	3–15%	questa back slopes & shale hills	residuum & alluvium	clay loam & loam	moderate	moderate	non-saline–slight	poor	no
MUE, MVE (83)	Podo-Cabba family complex	3–30%	benches, canyon rims, side slopes	residuum & colluvium	gravelly loam	moderate	none	non-saline	unsuitable (>35% coarse fragments)	yes
KXH, C84 (84)	Podo-Rock outcrop complex	50–70%	mountain slopes	colluvium & residuum	very bouldery sandy loam	high	none	non-saline	unsuitable (>35% coarse fragments)	yes
Ra (89)	Rafael silty clay loam	1–3%	alluvial fans, floodplains, valley floors	alluvium	silty clay loam	slight	none	slight–moderate	unsuitable (salinity >9 mmhos)	yes
RlB (90)	Ravola loam	1–3%	alluvial fans & narrow valley floors	alluvium	loam	moderate	moderate	very slight–slight	poor	no
RlB2, RlC2 (91)	Ravola loam, eroded	1–6%	alluvial fans & narrow valley floors	alluvium	loam	moderate	moderate	very slight–slight	poor	no
RTB	Ravola silty clay loam	1–3%	floodplains & alluvial fans	alluvium	silt loam	moderate	moderate	slight–moderate	poor	no
RnD (92)	Ravola-Gullied land complex	1–6%	alluvial fans & dissected narrow valley floors	alluvium	loam	moderate	moderate	very slight–slight	fair	no
GU	Ravola-Gullied land-Libbings complex	0%–steep	alluvial valley floors	alluvium	silt loam, silty clay loam, variable	moderate–very severe	moderate	slight–strong	unsuitable (salinity >9 mmhos/cm)	yes

**Table 3–13 (continued)
Characteristics of South Area Soils**

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil?
RUB2	Ravola-Homko complex	1–3%	alluvial fans, floodplains & alluvial valleys	alluvium	loam & clay loam	slight–severe	moderate	slight–strong	poor	no
RlA2	Ravola-Toddler Complex	1–6%	alluvial fans & narrow alluvial valleys	alluvium	silt loam & sandy loam	moderate	moderate	slight	fair	no
Rv	Riverwash	nearly level	streambeds	alluvium	variable	severe		variable	variable (unsuitable where >35% coarse fragments)	yes
Ry	Rock land	50–80%	colluvium & rock outcrop	Mancos Shale & Blackhawk Formation	stones, boulders, rock outcrop	severe		variable	unsuitable (>35% coarse fragments)	yes
RO (95)	Rock outcrop	steep–very steep	escarpments & ridges	Mancos Shale & Blackhawk Formation	rock outcrop	severe		n/a	unsuitable (>35% coarse fragments)	yes
EM96,RWG, C96 (96)	Rock outcrop-Rubbleland-Travessilla complex	30–70%	mesa escarpments & canyon sides	Mancos Shale & Blackhawk Formation	rock outcrop, stones, boulders, very gravelly fine sandy loam	severe		non-saline, n/a	unsuitable (>35% coarsefragments)	yes
177	Sager-Killpack association	1–10%	valley fill on shale pediments	alluvium & residuum	silty clay loam & silty clay	moderate–severe	moderate	slight	fair	no
Sa, Sb (99)	Saltair silty clay loam	0–3%	valley floors	alluvium	silty clay loam	slight	moderate	strong	unsuitable (salinity >9 mmhos)	yes
St	Stony alluvial land	nearly level	floodplains & mud rock flows	alluvium	variable	severe		variable	unsuitable (>35% coarse fragments)	yes
ClC, 542 (107)	Supert-Winetti complex	1–8%	narrow valleys & canyon floors	alluvium	clay loam & very bouldery loam	slight–moderate	none	non-saline	fair	no
561 (113)	Strych very stony loam	3–15%	benches & outwash plains	glacial outwash & alluvium	very stony loam	moderate	slight	non-saline	unsuitable (>35% coarse fragments)	yes

Table 3–13 (continued)
Characteristics of South Area Soils

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil?
534, BMD (114)	Strych very stony loam, dry	3–30%	alluvial fans & outwash plains	glacial outwash & alluvium	very stony loam	moderate	slight	non-saline	unsuitable (>35% coarse fragments)	yes
TDA	Toddler-Ravola-Glenton complex	1–6%	valley floors, floodplains, alluvial terraces, recent alluvial fans	alluvium	fine sandy loam & loam	slight–moderate	moderate	slight–moderate	fair	no
255	Travessilla-Gerst-Strych association	12–65%	sideslopes of mesas, structural benches, cuesta scarp faces	residuum, colluvium, alluvium	fine sandy loam, channery loam, very cobbly fine sandy loam	severe–very severe	slight	slight	unsuitable (>35% coarse fragments)	yes
RVD, NTD (120)	Travessilla-Rock outcrop complex	3%–very steep	benches & mesas	residuum, Mancos Shale, Blackhawk Fm.	fine sandy loam & bedrock	moderate	moderate	non-saline, n/a	fair–unsuitable (rock outcrop areas)	no
TrB	Trook fine sandy loam	1–3%	fan remnants	alluvium	fine sandy loam	slight	moderate	non-saline–slight	fair	no
TrC	Trook fine sandy loam	3–6%	fan remnants	alluvium	fine sandy loam	slight	moderate	non-saline–slight	fair	no
w	Water		ponds, streams							
Wo	Woodrow silty clay loam	1–3%	alluvial fans, floodplains, narrow alluvial valleys	alluvium	silty clay loam	moderate		non-saline–slight	fair	no
Mx	Mixed alluvial land	nearly level	stream channels	alluvium	variable	severe	variable	variable	variable (unsuitable where >35% coarse fragments	yes
SID2	Sanpete sandy clay loam, eroded	3–10%	benches	alluvium	sandy clay loam	severe		non-saline	fair	yes

Table 3–13 (continued)
Characteristics of South Area Soils

Map #	Soil Map Unit	Slope	Geomorphic Position	Parent Material	Texture	Water Erosion Hazard	Wind Erosion Hazard	Salinity	Suitability for Reclamation (limiting factor)	Critical Soil?
Sn	Sahly colluvial land	gently sloping–steep	on and at the base of slopes	Mancos Shale	mixture of soil, cobblestones, rock fragments	moderate–severe		variable	unsuitable >35% coarse fragments	yes

Note:
1 Soil map numbers in parentheses are map numbers used for these map units in the Soil Survey of Carbon Area, Utah (Jensen and Borchert 1988). The soil descriptions for these soils come from this soil survey.

3.5.2 Vegetation Types

Utah GAP resources, an analysis of satellite imagery that models vegetation landscapes on the basis of cover types, was used to identify vegetation types within the Project Area.

Eleven vegetation types were identified within the Project Area: pinyon/juniper, salt desert shrub, sagebrush/grassland, barren land, spruce fir, mountain fir, agriculture, wetland and riparian, aspen, mountain shrub, and urban. Some of these vegetation types include several GAP cover types that described vegetation communities that had strong similarities to one another. Specifically, the pinyon/juniper and sagebrush/grassland vegetation types represent combinations of several similar GAP cover types. The distribution and area of each vegetation type are shown on **Plate 3–4** and in **Table 3–14**, respectively.

Table 3–14
Vegetation Types by Facility

	Area (acres)			
Vegetation Type	**North Area**	**South Area**	**Pipeline**	**Total**
Sagebrush/grass	10,917	34,020	68	45,005
Pinyon/juniper	5,315	31,359	51	36,725
Salt desert	2,079	17,244	65	19,388
Agriculture	39	5,854	73	5,966
Barren lands	0	2,163	0	2,163
Mountain fir	0	1,186	0	1,186
Riparian/wetland	0	886	3	889
Urban	0	243	1	244
Spruce fir	0	97	0	97
Ponderosa pine – mountain shrub	0	89	0	89
Aspen	0	30	0	30
TOTAL (ac)	18,350	93,170	261	111,782

A more detailed vegetation and soils description known as the Ecological Site Description has been jointly created by the NRCS and BLM. This document details in depth the drier four of the nine GAP vegetation cover types by breaking these four cover types into sixteen eco-sites (**Table 3–15**). If unique situations arise calling for a more site specific management, these Ecological Site Descriptions will be referred to for guidance.

3.5.2.1 Sagebrush/Grass

The sagebrush/grass vegetation type accounts for 45,005 acres (40 percent) of the Project Area. It represents the consolidation of the sagebrush, sagebrush/perennial grass, and grassland GAP cover types. All three types are found in the semi-arid areas (10 to 14 inches of annual precipitation) of Castle Valley on gently-sloping terrain with deep loamy soils. Benches, terraces, alluvial fans and valley floors from about 5,700 to 7,500 feet all provide suitable terrain for this vegetation type.

Table 3–15
Ecological Sites Found Within the Project Area

Vegetation Type	Site Name	Site Number	Habitat Type
Salt Desert	Desert Loam	D34X106	ATCO/ORHY
Salt Desert	Desert Loamy Clay (ATOC)	D34X109	ATCO/HIJA-ORHY
Salt Desert	Desert Sandy Loam	D34X115	ORHY-HIJA
Salt Desert	Desert Shallow Clay	D34X117	ATCO4-HIJA
Salt Desert	Desert Very Steep Shallow Loam	D34X133	ATCO/HIJA-ELSA
Sagebrush	Semidesert Sandy Loam	D34X216	ATCA2-ARTRW/ORHY-STCO4
Sagebrush	Semidesert Shallow Loam (PJ)	D34X233	JUOS-PIED/ARARN/ELSA
Pinyon/Juniper	Semidesert Stony Loam (JP)	D34X247	JUOS-PIED/ELSA
Pinyon/Juniper	Semidesert Very Steep Loam (JP)	D34X253	JUOS-PIED
Pinyon/Juniper	Semidesert Very Steep Shallow Clay	D34X255	JUOS-PIED
Pinyon/Juniper	Upland Stoney Loam (JP)	D34X330	PIED-JUOS/ARARN/AGSP
Pinyon/Juniper	Upland Stoney Loam (PJ)	D34X333	PIED-JUOS/ARARN/AGSP
Pinyon/Juniper	Upland Very Steep Shallow Loam (JP)	D34X342	PIED-JUOS/CEMO2/ELSA
(Sagebrush)	Upland Shallow Clay Loam (JP)	(not assigned)	ELSA-ORHY
(Sagebrush)	Upland Loam	(not assigned)	ATCO-ORHY
Sagebrush	Semidesert Shallow Loam	(not assigned)	ARNV-ORHY

Big sagebrush, black sagebrush, and silver sagebrush (*Artemisia cana*) are commonly dominant in this vegetation type. Pinyon and juniper are associated with the moister portions of the sagebrush/grass type, as are bitterbrush (*Purshia tridentata*), snakeweed, winterfat (*Krascheninnikovia lanata = Erotia lanata*), shadscale (*Atriplex confertifolia*) and rabbitbrush (*Chrysothamnus* spp.). Principal perennial grasses are bluebunch wheatgrass (*Agropyron spicata*), sandberg bluegrass, needleandthread, sand dropseed (*Sporobolus cryptandrus*), blue gramma (*Bouteloua gracilis*), Thurber's needlegrass (*Stipa thurberiana*), western wheatgrass, squirreltail, galleta (*Hilaria jamesii*), and Indian ricegrass. The grass component of the sagebrush/grass type increases in dominance with drier environments and cheatgrass (*Bromus tectorum*) is common in disturbed areas.

3.5.2.2 Pinyon/Juniper

The pinyon/juniper vegetation type accounts for 36,725 acres (33 percent) of the Project Area. It represents the consolidation of three Utah GAP cover types: pinyon/juniper, pinyon and juniper. Pinyon/juniper woodlands occur in the semi-arid areas (10 to 12 inches of annual precipitation) of Castle Valley on shallow or rocky soils. Benches, mesas, mountain slopes, and outwash plains all provide suitable terrain for this vegetation type. Portions of the pinyon/juniper vegetation type were chained in the 1960s and 1970s to increase forage for livestock and wildlife and improve watershed values. Crested wheat (*Agropyron crisatum*) was interseeded after chaining and is now a dominant grass in the understory of the chained areas.

Juniper (*Juniperus scopularum*) and pinyon (*Pinus edulis*) are co-dominant species in this vegetation type, although juniper may become dominant at lower elevations (5,500 to 7,000 feet), and pinyon may become dominant at higher elevations (> 7,000 feet). Below this open canopy of dwarf conifer trees lies a highly variable understory. Dominant understory shrubs range from big sagebrush (*Artemisia tridentata*), commonly found in openings underlain by deep loamy soil, to black sagebrush (*Artemisia nova*) and mountain mahogany (*Cercocarpus montanus*) on shallow, lithic soils. Snakeweed (*Gutierrezia sarothrae*) and little rabbitbrush (*Chrysothamnous viscidiflorus*) are often found in areas of poor range conditions or in unsuccessful range improvement areas.

Common grasses in the pinyon/juniper woodlands include Sandberg bluegrass (*Poa secunda*), needleand-thread (*Stipa comata*), Indian ricegrass (*Stipa hymenoides=Oryzopsis hymenoides*), squirreltail (*Elymus elymoides=Sitanion hystrix*), and western wheatgrass (*Agropyron smithii*). Common forb species include stemless golden weed (*Halopappus acaulis=Stenotus acaulis*), oval buckwheat (*Eriogonum ovalifolium*), yellow-eye cryptantha (*Cryptantha flavoculata*), scarlet gilia *(Gilia aggregata = Ipomopsis aggregata*), dwarf cat eye, brittle pricklypear cactus (*Opuntia fragilis*), claretcup cactus (*Echinocereus triglochidiatus*), and heartleaf twistflower (*Streptanthus cordatus*).

3.5.2.3 Salt Desert

The salt desert vegetation type accounts for 19,388 acres (17 percent) of the Project Area. Also referred to as the saltbush-greasewood vegetation type, the salt desert occupies arid (6 to 10 inches of annual precipitation) areas of Castle Valley (5,400 to 5,900 feet). Within this moisture and elevational zone, shale hills, alluvial fans, and valley floors all provide suitable terrain. Erosion and extensive gully formation are common, and vegetation can often be locally sparse or absent.

Chenopod shrubs and sub-shrubs dominate the salt desert landscape. Shadscale is common on upland portions, hills support mat saltbush (*Atriplex corrugata*) and Nuttall saltbush, and saline bottoms and washes contain big rabbitbrush and greasewood (*Sarcobatus vermiculatus*). Other characteristic species include Castle Valley saltbush (*Atriplex cuneata*), Mormon tea (*Ephedra* spp.), budsage (*Artemisia spinescens*), horsebrush (*Tetradymia canescens*), snakeweed, and winterfat. Galleta grass, Indian ricegrass, sand dropseed and alkali sakaton (*Sporobolus airoides*) are dominant grasses. Halogeton (*Halogeton glomeratus*) an Eurasian native introduced in the 1930s, is the primary forb, although gray molly (*Kochia vestita*) also occurs. Extensive areas are dominated by cheatgrass.

3.5.2.4 Agriculture

This cover type accounts for 5,966 acres (5 percent) of the Project Area. Agricultural lands are scattered throughout the eastern half of the Project Area. Primary crops are alfalfa, small grains (primarily oats and barley), and corn for silage. They may also be irrigated for pasture.

3.5.2.5 Barren Lands

The barren lands vegetation type accounts for 2,163 acres (2 percent) of the Project Area. The vegetation type is confined to severe topographical environments such as cliffs or steeply sloped mancos shale. These steep environments are restrictive to vegetation growth, and thus support a depauperate plant community, if any at all.

3.5.2.6 Mountain Fir

The mountain fir vegetation type accounts for 1,186 acres (1 percent) of the Project Area. This conifer forest is principally dominated by combinations of white fir (*Abies concolor*) and Douglas fir (*Pseudotsuga* *menziesii*). Primary associated tree species include ponderosa pine (*Pinus ponderosa*), pinyon pine, Englemann spruce, blue spruce (*Picea pungens*) and sub-alpine fir.

3.5.2.7 Urban

While not a vegetation and cover type, urban areas account for 244 acres (<1 percent) of the Project Area. Urban areas encompasses communities, such as Price, Huntington, Kenilworth, and Elmo, and areas disturbed by mining and industrial activity.

3.5.2.8 Spruce-fir

The Spruce-fir vegetation type accounts for 97 acres (<1 percent) of the Project Area. The dominant species of this type, Englemann spruce (*Picea englemanni*) and sub-alpine fir (*Abies lasiocarpa*), require temperature and moisture regimes that are limited to the higher elevations of the Wasatch Plateau.

3.5.2.9 Ponderosa Pine – Mountain Shrub

The Ponderosa Pine – Mountain Shrub vegetation cover type accounts for 89 acres (<1 percent) of the Project Area. Its extent is restricted to one location within the Project Area, along the western edge of the South Area, south of Cottonwood Creek. The overstory of this cover type is dominated by open stands of ponderosa pine (*Pinus ponderosa*). Woody shrubs, such as serviceberry (*Amelanchier* ssp.), Gambel oak (*Quercus gambelii*), curlleaf mountain mahogany (*Cercocarpus ledifolius*), cliff rose (*Purshia mexicana*), snowberry (*Symphoricarpos* ssp.), chokecherry (*Prunus virginiana*) and ceanothus (*Ceanothus* ssp.), are common in the midstory. The understory is composed of herbaceous species such as Letterman needlegrass *(Stipa lettermanii*), bluegrass (*Poa* ssp.), Indian ricegrass (*Stipa hymenoides*), western wheatgrass (*Agropyron smithii*) and slender wheatgrass (*Elymus trachycaulus*). The extent of herbaceous cover in the understory commonly varies depending upon the density of mid and overstory species.

3.5.2.10 Aspen

The Aspen vegetation cover type accounts for 30 acres (<1 percent) of the Project Area. The extent of this vegetation type within the Project Area is restricted to one location in the northwestern edge of the South Area. Widely distributed in North America, aspen (*Populus tremuloides*) is known for its diverse communities. Located in relatively moist environments, the understory community of an aspen grove is luxuriant in diversity and production, especially in comparison to the understories associated with conifer forests. Typical components are shrubby cinquefoil (*Pentaphylloides floribunda*), harebell (*Campanula roundifolia*), Fendler meadowrue (*Thalictrum fendleri*), wild geranium (*Geranium caespitosa*), bluegrass (*Poa* ssp.), and timothy (*Phelum* ssp.).

3.5.2.11 Riparian and Wetland Areas

Riparian and wetland communities account for 889 acres (<1 percent) of the Project Area. Wetlands are discussed in this section; riparian areas are discussed separately in **Section 3.6.**

Wetlands are a subset of what the U.S. Army of Engineers (COE) defines as "Waters of the U.S." They are characterized as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. (40 CFR 230.3, 33 CFR 328.3)

Linked to the presence of water, their extent is naturally limited in the vicinity of the Project Area. While limited in coverage, they are of great importance due to their productivity and species diversity. No wetlands have been identified in the North Area.

3.5.3 Noxious Weeds

Utah is experiencing a rapid introduction and spread of noxious weeds throughout the state on all types of land ownership. The potential for noxious weeds to continue to spread on BLM administered lands is great. The number of different noxious and invasive weeds of concern continues to increase. Federal, state, and local governments have entered into partnership to eliminate and prevent the infestation and spread of weeds that cause economic loss of crops and animal production, esthetics and recreational experiences, and general condition of native vegetation and soil stability.

Non-native plant species are increasingly common in the vicinity of the Project Area (BLM 1997c). Characteristically opportunistic in nature, they are very successful at invading into freshly disturbed soil. Their occurrence is therefore commonly tied to the activities which cause ground disturbance. Furthermore, the invasion of non-native plant species is fostered by traffic corridors which serve to transport the seeds of non-native species into previously uncontaminated areas.

Once established, non-native plant species out-compete and eventually replace native species, thereby reducing the forage content of the land, and the overall vigor of the plant community. As a consequence of these effects, many non-native species are viewed as detrimental to the environment, and are regulated as such. A noxious weed is defined by the Utah Noxious Weed Act as any species of plant that is especially injurious to public health, crops, livestock land or other property. The State of Utah has given 17 plant species this designation, and further, has identified 15 new and invading species that have the potential to become noxious. These species are listed in **Table 3–16.**

Emery county has further identified several additional problem species: houndstongue, whorled milkweed, buffalobur and chicory, Russian olive. Control and/or eradication of noxious weeds within the Project Area is managed by local, state, and federal authorities (Emery County, Carbon County, Utah Cooperative Extension Service-Carbon and Emery counties, BLM). Integrated pest management is followed in both counties and entails the implementation of biological, mechanical and chemical controls. Mechanical controls are sometimes impractical, however, in areas with difficult terrain (Winger 1997).

There are several ways that noxious or invasion weeds are being introduced into Carbon and Emery counties. Examples of how these plants and seeds are being transported include: escape of ornamental flowering plants from private yards, transport of livestock within and across county lines, use of recreational vehicles and hunting animals, commercial transport of goods on the railroad lines and highways, and transport of heavy equipment used in the oil and gas fields.

3.6 RIPARIAN AREAS

Riparian areas are a "form of wetland transition between permanently saturated wetlands and upland areas. These areas exhibit vegetation or physical characteristics reflective of permanent surface or subsurface water influence" (Leonard, et al. 1992). The vegetation that visually defines a riparian area is valuable in providing sediment retention, floodflow alternation, nutrient removal and transformation, increased production (relative to uplands) for livestock and wildlife forage, habitat diversity for aquatic and terrestrial wildlife, and

Table 3–16
Noxious Weeds of Concern

	State Listed Noxious Weeds	
Bermuda grass	Canada thistle	leafy spurge
quackgrass	dyers woad	pepperweed
medusahead	diffuse knapweed	hoary cress
musk thistle	Russian knapweed	field bindweed
yellow starthistle	spotted knapweed	perennial sorhgum
Scotch thistle	squarrose knapweed	
	New and Invading	
black henbane	yellow toadflax	yellow nutsedge
camel thorn	water hemlock	wild proso millet
dalmatian toadflax	St. Johnswort	velvetleaf
goatsrue	purple starthistle	silverleaf nightshade
jointed goatgrass	poison hemlock	purple loosestrife

streambank stability. Riparian areas are an important resource on public lands and are managed as such (Almand and Krohn 1978, BLM 1991b). Their occurrence is generally associated with flowing water and they can be characterized as wetland or non-wetland.

Riparian communities were inventoried on BLM land for the North and South areas. As shown on **Plate 3–4**, the majority of riparian communities on private land occurs in natural drainages (Huntington Creek and Cottonwood Creek). Several wells have been drilled in riparian areas on private land along Cottonwood Creek. Approximately 20 percent of the riparian vegetation within the South Area can be found along man-made canals southwest of Castle Dale, Utah.

The BLM defined three general types of riparian communities on the basis of species dominance. Cottonwood (*Populus angustifolia, P. fremontii*) dominated riparian areas are typically located along perennial streams, such as Huntington Creek or Cottonwood Creek. These communities are representative examples of desert riparian streams with narrow floodplains. Other common species within these communities include elm (*Ulmus* sp.), Russian olive (*Elaeagnus angustifolia*), tamarisk, copperweed, coyote willow (*Salix exigua*), saltgrass (*Distichlis spicata*), and horsetail (*Equisetum arvense*). Big sagebrush (*Artemisia tridentata*), greasewood (*Sarcobatus vermiculatus*), and rubber rabbitbrush (*Chrysothamnus nauseosus*) are found on the adjacent narrow floodplains.

Tamarisk (*Tamarisk ramosissima*) dominated communities also are present along perennial streams and maybe found near irrigation canals. These communities may intermix with the cottonwood community or may be found as monocultures.

The least common of the three types of riparian community is the grass community. This community is dominated by saltgrass (*Distichlis spicata*), and sedges (*Carex* sp.) and typically occurs as the perennial drainages pass through salt desert shrub communities.

3.7 WILDLIFE

3.7.1 Aquatic Species

Information for this section of the report was gathered from three primary sources. First, resource management agencies were contacted for information on fish species status, occurrence, and use of habitats within the Project Area. Second, both published and unpublished literature was used to supplement the agencies' information. Third, field surveys of the aquatic resources were conducted on October 21 to 23, 1997. The survey locations are shown on **Plate 3–2**. The surveys included macroinvertebrate sampling and electroshocking.

3.7.1.1 North Area

Reconnaissance surveys in October 1997 documented that drainages within the North Area are intermittent and unable to support fish. Therefore, no fish species occur within the North Area.

3.7.1.2 South Area

The fisheries resource within the South Area is restricted to Huntington and Cottonwood Creek drainages, as well as numerous ponds and reservoirs. Huntington Lake contains a bass and trout fishery. The ponds and reservoirs are reported to have nonnative stocked game fish species such as trout, bass, and bluegill. The San Rafael River (downstream of the Project Area) contains mountain sucker, bluehead sucker, flannelmouth sucker, mottled sculpin, speckled dace, Utah chub, carp, bluegill, catfish, red shiner, fathead minnow, sand shiner, and green sunfish (Masslich and Holden 1995, BLM 1997c).

Huntington and Cottonwood Creek drainages within the South Area were considered the analysis area for this project. During October 1997, the analysis area was surveyed for fish and macroinvertebrates. Three stations on Cottonwood Creek and two stations on Huntington Creek were surveyed. Additionally, three tributaries to Huntington Creek were surveyed (Meetinghouse, Fish, and Deer Creeks). Results of these surveys are described below and summarized in **Table 3–17**.

3.7.1.2.1 Cottonwood Creek

Brown trout were the only trout collected in Cottonwood Creek during the 1997 survey. In addition to brown trout, nonnative Snake River cutthroat trout were found in 1980 (UDWR 1980). Therefore, cutthroat may still occur in limited numbers within the Cottonwood Creek drainage.

Native species collected from Cottonwood Creek in 1997 included speckled dace, mottled sculpin, and bluehead sucker. Additionally, a flannelmouth sucker was collected in 1980 (UDWR 1980), indicating the potential for this species to still occur in limited numbers in Cottonwood Creek. Bluehead sucker and flannelmouth sucker are Utah state-listed sensitive species/species of special concern and are discussed further in **Section 3.8.3**.

Utah chub was newly found in Cottonwood Creek during the 1997 surveys. This species is not native to the drainage. It presumably came from Joe's Valley Reservoir, located upstream of the sample station. This reservoir has a increasing population of Utah chub (Cavalli 1998).

Table 3–17
Summary of Fish Electroshocking Results From Stations in Huntington, Meetinghouse, Fish, Deer, and Cottonwood Creeks
October 21–23, 1997

Fish Species		CC1	CC2	CC3	HC1	HC2	MC1	FC1	DC1
		Sample Stations (Number of Fish/Mile[1])							
Salmonidae (trout)									
Brown trout	(*Salmo trutta*)	53	70	158	211	282	no	no	no
Cutthroat trout	(*Oncorhynchus clarki*)[2]	0	0	0	35	35	fish	fish	fish
Rainbow Trout	(*Oncorhynchus mykiss*)	0	0	0	0	18			
Cyprinidae (minnows)									
Speckled dace	(*Rhinicthys osculus*)[3]	70	0	0	0	0			
Utah chub	(*Gila atraria*)	0	18	0	0	0			
Catostomidae (suckers)									
Bluehead sucker	(*Catostomus discobolus*)[3]	53	0	0	0	0			
Cottidae (sculpins)									
Mottled sculpin	(*Cottus bairdi*)[3]	158	246	246	0	0			
Total Population Estimate		334	334	405	246	334	0	0	0
Total Number of Species		4	3	2	2	3	0	0	0

Notes:
1. Population estimates were calculated using the statistical program MicroFish 3.0 (Deventer and Platts 1989)
   - At each stream station, 300-foot reaches were electroshocked (two passes)
   - CC = Cottonwood Creek; HC = Huntington Creek; MC = Meetinghouse Creek; FC = Fish Creek; DC = Deer Creek; See **Plate 3–2** for exact locations of stations.
   - Average Daily Flows (cfs) during the survey were: Cottonwood = 96 cfs; Huntington = 162 cfs; Meetinghouse = <1 cfs; Fish = <1 cfs; Deer = <1 cfs.
   - Huntington Creek was running higher-than-normal flows for October due to reservoir releases, making sampling efficiency questionable especially for potential sculpins.
2. Cutthroat trout collected were not the native Colorado River cutthroat trout subspecies (*Oncorhynchus clarki pleuriticus*)
3. Fish species native to the drainage

As with the fish survey, aquatic macroinvertebrates were sampled at three stations within Cottonwood Creek in the fall of 1997. The methods consisted of compositing three quantitative Surber (1 square foot) samples within riffle habitats. Several metrics were applied to the macroinvertebrate data with the following results.

The biotic indices applied to the Cottonwood Creek data suggested excellent-to-good biotic condition, with most species having relatively low pollution tolerances (**Table 3–18**). Accordingly, more than 90 percent of the organisms collected came from the orders ephemeroptera (mayflies), trichoptera (caddisflies) and plecoptera (stoneflies), or EPT orders, which are generally considered indicators of high water and habitat quality. However, abundance, richness, and diversity values were found to be only fair. These results suggest that Cottonwood Creek historically had excellent biotic condition (as shown by the presence of cleanwater taxa) but that their populations are currently depressed.

3.7.1.2.2 Huntington Creek

Reservoir releases into Huntington Creek during the 1997 survey created abnormally high flows of 162 cfs, compared to a normal flow of 30 to 40 cfs, at the two sample stations. This, along with the resulting high turbidity, made fish sampling difficult. Therefore, the 1997 fish and macroinvertebrate data collected in Huntington Creek should be considered minimum population estimates, with sculpins and other small fish potentially being missed entirely.

Table 3–18
Macroinvertebrate Bioassessment Metrics for Stations in Huntington, Meetinghouse, Fish, Deer, and Cottonwood Creeks, October 21–23, 1997

	Sample Stations[1]							
	CC1	CC2	CC3	HC1	HC2	MC1	FC1	DC1
General Metrics								
Total Abundance (# / ft²)	40	28	47	66	70	9	15	59
Total Abundance (# / m²)	434	301	506	707	753	100	161	639
Total Number Taxa	17	11	16	19	18	9	10	11
# EPT Taxa	11	9	9	14	12	6	6	5
% EPT Taxa	90.1	94.0	76.6	82.2	80.0	89.3	82.2	94.4
% Dominant Taxon	62.8	34.5	27.7	44.2	29.5	50.0	48.9	52.8
% Chironomidae	1.7	4.8	5.0	6.6	13.3	0.0	0.0	0.0
EPT/Chironomidae	54.50	19.75	15.43	12.46	6.00	---	---	---
Diversity Indices								
Shannon (H)	2.21	2.68	3.22	2.92	3.26	2.42	2.47	1.71
Evenness (e)	0.35	0.73	0.81	0.53	0.72	0.78	0.70	0.36
Biotic Indices								
HBI	3.7	3.5	4.3	3.4	4.1	4.8	3.6	4.3
CTQ	91.3	75.9	83.5	84.3	83.1	94.9	82.6	90.8
Percent Composition Per Order								
Ephemeroptera	10.7	29.8	37.6	17.3	37.6	21.4	4.4	38.8
Plecoptera	12.4	25.0	8.5	17.8	10.5	0.0	22.2	2.2
Trichoptera	66.9	39.3	30.5	47.2	31.9	67.9	55.6	53.4
Odonata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diptera	5.0	6.0	10.6	7.1	16.2	3.6	0.0	2.8
Coleoptera	5.0	0.0	0.0	9.1	3.8	7.1	8.9	1.1
Hemiptera	0.0	0.0	2.1	0.0	0.0	0.0	2.2	0.0
Miscellaneous Taxa	0.0	0.0	10.6	1.5	0.0	0.0	6.7	1.7

Notes:

1 For station locations, refer to **Plate 3–2**.

Abundance — Under certain types of stresses, this value may be increased (by tolerant organisms) or reduced (by lowering the number of nontolerant organisms).

Total # of Taxa — The total number of taxa (richness) generally increases with increasing biotic condition.

EPT Taxa — The total number of distinct taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera. This value summarizes taxa richness within the insect orders generally considered sensitive to pollution.

% EPT Taxa — The percent contribution of the orders Ephemeroptera, Plecoptera, and Trichoptera.

% Dominant Taxon — The percent contribution of the most numerous taxon found. Undisturbed environments generally support communities having large numbers of species with no individual species present in overwhelming abundance.

% Chironomidae — The percent contribution of the family Chironomidae. Disproportionate dominance of this generally tolerant group usually indicates poor biotic condition.

EPT/Chironomidae — Skewed population having a disproportionate number of the tolerant chironimids relative to the more sensitive EPT group may indicate environmental stress.

Shannon H — A diversity index where relative abundances of the different taxa are taken into account. In general, values from 3 to 5 indicate clean water (good), 1 to 3 moderately polluted water (fair), and values below 1 indicate heavily polluted water (poor).

Evenness — The measure of how evenly the individuals are distributed among species. Values greater than 0.5 are considered to characterize natural stream communities. Even slight levels of degradation can reduce evenness below 0.5, and generally below 0.3.

HBI — The HBI (modified Hilsenhoff biotic index) summarizes the benthic community's overall tolerance to pollution. 0.00-3.75 (excellent), 3.76-4.25 (very good), 4.25-5.00 (good), 5.01-5.75 (fair), 5.76-6.5 (fairly poor), 6.51-7.25 (poor), and 7.26-10.00 (very poor).

CTQ — (Community Tolerance Quotient). Similar to the HBI, each individual organism in a sample has a preassigned tolerance value. Mean values range from 40 to 108. The higher numbers indicate more tolerant communities and may show stressed conditions.

Brown trout was the dominant species found in Huntington Creek during the 1992 and 1997 surveys. Additionally, cutthroat trout and rainbow trout were found in limited numbers during both surveys. The cutthroat trout collected in 1997 were not the native Colorado River cutthroat trout subspecies. Potential occurrence of this subspecies is discussed in **Section 3.8.3.**

The native species mottled sculpin probably still occurs in Huntington Creek. Although not found in 1997, mottled sculpins were found in Huntington Creek during the 1992 surveys (UDWR 1992). This species was not found in 1997, most likely because of the high flows/turbidity encountered during the survey.

No suckers were found in Huntington Creek during either survey. However, the presence of spawning suckers (bluehead or mountain) in three tributaries to Huntington Creek in 1982 indicates that they potentially occur in limited numbers within the mainstem of Huntington Creek. Whether the suckers found in 1982 were bluehead or mountain suckers is unknown (Berg 1997).

No fish were found in Meetinghouse, Fish, and Deer creeks during the October 1997 surveys. However, June 1982 surveys found a significant number of spawning bluehead/mountain suckers in Fish and Deer creeks (UDWR 1982). The lack of suckers in 1997 is likely due to the survey being conducted outside of the suckers spawning season. The 1982 data indicate that Fish and Deer creeks are potentially important tributaries for bluehead/mountain sucker spawning and recruitment to Huntington Creek.

The 1982 surveys found nonnative trout immediately above the mouths of Deer Creek and Meetinghouse Creek, indicating occasional resting or feeding in the extreme lower section of these creeks. No trout were found above these confluence areas during either 1982 or 1997.

A notable difference between the 1982 and 1997 Huntington Creek surveys was that speckled/longnose dace were found in Fish Creek in 1982 and not in 1997. This indicates that the species may no longer occur there. Whether the species found in 1982 was speckled dace or longnose dace was unknown (Berg 1997).

As with the fish survey, aquatic macroinvertebrates were sampled at two stations in the mainstem of Huntington Creek and one station in three of its tributaries: Meetinghouse, Fish, and Deer creeks. Bioassessment metric results in the mainstem of Huntington Creek were similar to Cottonwood Creek's results. Abundance and richness values were slightly higher than in Cottonwood. As expected, data from the three small tributary streams indicated lower abundance, richness, and diversity than Huntington Creek. Macroinvertebrate data collected by the Forest Service from Huntington Creek in the same stream section showed similar results to the 1997 data (Mangum 1982).

3.7.2 Terrestrial Wildlife

Wildlife habitats that would be affected by the project include the areas that would be physically disturbed by the construction of wells, access roads, pipelines, and production facilities. Also indirectly, habitats surrounding these actions would be affected. However, the shape and extent of the areas affected would vary by species and by facility.

Eleven vegetation types have been identified within the Project Areas. They include pinyon-juniper, salt desert shrub, sagebrush-grassland, barren land, spruce fir, aspen, mountain fir, ponderosa pine-mountain shrub, agricultural, wetland and riparian, and urban. The characteristics of each type are described in **Section 3.5**.

Information for this section of the report was gathered from three primary sources. First, resource management agencies were contacted for information regarding the general area. Agencies contacted included the U.S. Fish and Wildlife Service (USFWS), BLM, and UDWR. Second, both published and unpublished literature was used to supplement the agencies' information. Third, a site reconnaissance of the area was conducted in October, 1997. The following discussion describes each of the major wildlife groups within the Project Area.

3.7.2.1 Big Game

The Project Area is within herd unit areas for mule deer, elk, and pronghorn antelope. These species occur throughout the Project Areas in areas of suitable habitats. The UDWR has identified various types of ranges for each species, including critical and high value winter ranges. These types of ranges are defined as:

- Critical or crucial ranges are sensitive use areas that are limited in availability or provide unique qualities for high interest wildlife. These areas constitute irreplaceable, critical requirements for these species.

- High value ranges are intensive use areas that due to relatively wide distribution do not constitute critical values but which are highly important to high interest wildlife.

3.7.2.1.1 Elk

Elk occurred within the mountainous regions of Utah historically. However, due to unlimited hunting, elk populations in the state diminished until 1898 when elk hunting was prohibited. Elk transplants were initiated in 1912 and continued until 1925. Today elk again occur within the mountainous regions of the state and are considered a big game species.

Within the Project Area, elk may be found in any of the eleven vegetation types, except urban. However, they would most likely be found in more common types, such as pinyon-juniper and sagebrush-grassland. Elk also would use the limited amounts of forest types present in the South Area, including mountain fir, aspen, and spruce-fir. Use of some vegetation types, such as barren lands and salt desert shrub, probably is limited to minor foraging, lounging, and travel between more suitable types.

For 1998, UDWR is revising the herd unit boundaries for elk. Previously, the North Area was part of UDWR's Range Creek Herd Unit (#24) and the South Area was part of the Manti Herd Unit (#23). With the revisions proposed by UDWR, the North Area would be encompassed by the Anthro/Range Creek Herd Unit (#11) and most of the South Area would be encompassed by the Manti-Nebo Herd Unit (#16). Although small portions of the South Area and pipeline corridor east of State Highway 10 would be encompassed by the San Rafael Herd Unit (#12), any elk using these small areas would probably be elk from the Manti-Nebo Herd Unit.

Although the North Area occurs within UDWR's Anthro/Range Creek Herd Unit, elk do not use or inhabit the North Area. Furthermore, habitats present within the North Area have not been delineated as critical or high value ranges. Elk occupy the habitats present in other portions of the Anthro/Range Creek Herd Unit.

The South Area occurs within the Manti portion of the Manti-Nebo Herd Unit, which contains the largest elk herd in Utah. The target winter population for this portion of the Herd Unit is 12,000 elk, which accounts for most of the 13,400 target population for the entire Manti-Nebo Herd Unit. Additionally, UDWR wants to attain a minimum bull to cow ratio of 8 bulls to 100 cows (as measured during the biennial winter aerial census) with at least four of the eight bulls being mature (2.5 years of age or older).

In general, the Manti subpopulation of elk spends summers west of the Project Area at higher elevations in the Manti-La Sal National Forest. Winters are spent at lower elevations in and near the Project Area. Portions of areas (**Plate 3–5**) where the elk winter within the South Area have been delineated as crucial winter range and high priority winter range. The 16,410 acres of crucial winter range occur west of Huntington on the lower slopes of East Mountain (**Plate 3–5**), primarily north of Danish Bench. About 7,940 acres of high priority winter range have been delineated near the mouth of Huntington Canyon, in the Cottonwood Creek drainage, and along the east-facing slopes in the Rock Creek drainage (**Plate 3–5**).

The proposed pipeline corridor occurs within the Manti-Nebo Herd Unit and the San Rafael Herd Unit. However, no crucial or high priority winter ranges have been delineated along the pipeline corridor.

3.7.2.1.2 Mule Deer

Within the eastern portion of Utah, mule deer occur throughout the area with the highest populations occurring within mountainous regions. Their populations fluctuate based on weather conditions, such as drought and severe winters. Overall, populations have declined in eastern Utah due to severe drought conditions from 1988 through 1992. This was followed by the severe winter of 1992–1993. These conditions resulted in high deer mortalities but deer populations appear to be increasing recently.

Mule deer occur throughout the entire Project Area and may be found in any of the eleven vegetation types, except urban. However, they would most likely be found in more common types, such as pinyon-juniper and sagebrush-grassland. Use of some vegetation types, such as barren lands and salt desert shrub, probably is limited to minor foraging, lounging, and travel between more suitable types.

As discussed for elk, UDWR is revising the herd unit boundaries for deer. Previously, the North Area was part of UDWR's Range Creek Herd Unit (#32) and the South Area was part of the Northeast and Southeast Manti Herd Units (#30 and #31). With the revisions proposed by UDWR, the North Area would be encompassed by the Anthro/Range Creek Herd Unit (#11) and most of the South Area would be encompassed by the Manti-Nebo Herd Unit (#16). Small portions of the South Area and pipeline corridor east of State Highway 10 would be encompassed by the San Rafael Herd Unit (#12). UDWR has delineated a total of 1,440,510, 2,249,971, and 59,796 acres of identified ranges (year-long, summer, and winter) within the Anthro/Range Creek, Manti-Nebo, and San Rafael herd units, respectively.

In its Draft Management Plan for the Anthro/Range Creek Herd Unit, the UDWR indicates its target winter herd size for the Range Creek subpopulation (which includes the North Area) is 6,000 wintering mule deer. The target winter herd size for the entire Herd Unit is 8,500 deer. UDWR also has established a goal for the herd of a post-season buck to doe ratio of 15:100, with 30 percent of the bucks being three point or better.

Almost all of the North Area has been delineated as crucial winter range or high priority winter range (**Plate 3–6**). The 11,850 acres of crucial winter range occupy most of the northeast portion of the North Area. High priority winter range (almost 6,230 acres) is more concentrated in the northwest portion and along the southern boundary. Only a small area in the southeast corner of the North Area (270 acres) has not been delineated as crucial winter range or high priority winter range.

According to its Draft Management Plan for the Manti-Nebo Herd Unit, the UDWR would manage the Manti Mountain or Wasatch Plateau portion of the unit (which encompasses almost all the South Area and pipeline corridor) to achieve a target population size of 38,000 deer. The target winter herd size for the entire Herd Unit is 60,600 animals. UDWR also has established a goal for the herd of a post-season buck to doe ratio of 15:100, with 30 percent of the bucks being three point or better.

Both crucial winter range and high priority winter range have been delineated within the South Area (**Plate 3–6**). Most of the 31,290 acres of crucial winter range occurs along the east face of the escarpment in and between the Cottonwood Creek and Huntington Creek drainages. A smaller area of crucial winter range occurs in the Rock Creek drainage in the southwest part of the South Area. About 26,120 acres of the South Area have been delineated as high priority winter range. This range extends from the South Area's northern boundary to its southern boundary along the face of the escarpment. Neither the eastern part of the South Area nor the pipeline corridor encompass any crucial or high priority winter ranges.

3.7.2.1.3 Pronghorn Antelope

The Icelander Wash Herd Unit (#11) encompasses the Project Area. Within this unit, about 793,600 acres of pronghorn habitat have been identified, most of which is managed by the BLM. In 1996–1997, ratios of fawns to does and bucks to does before the hunting season was about 31 to 100 and 30 to 100, respectively (Evans and Westphal, 1997). Pronghorn antelope typically inhabit open vegetation types where trees are limited and visibility is high. Thus, within the Icelander Wash Herd Unit, pronghorns are expected to occur primarily within the sagebrush grasslands, salt desert shrub, agricultural, and barren vegetation types.

Although the Project Area occurs within the Icelander Wash Herd Unit, it is isolated from the rest of the Herd Unit by major highways and their fences. Thus, no antelope currently occupy either the North Area or the South Area. Furthermore, no critical or high priority pronghorn ranges have been delineated within the Project Area or along the pipeline corridor.

3.7.2.2 Raptors

General distribution records and field observations made by biologists of the UDWR, BLM, and Forest Service document the occurrence of a variety of raptors in the Project Area and immediate vicinity. Species identified include the red-tailed hawk, ferruginous hawk, rough-legged hawk, golden eagle, bald eagle, prairie falcon, peregrine falcon, American kestrel, great horned owl, short-eared owl, and northern harrier. Furthermore, surveys and other observations have documented the presence of nests for five species. They are the golden eagle, ferruginous hawk, red-tailed hawk, prairie falcon, and peregrine falcon. Although no records exist to document nests of other species, several additional species probably nest in the Project Area, including the northern harrier, American kestrel, and great horned owl. All raptors and their nests are protected from take or disturbance under the Migratory Bird Treat Act (16 USC, § 703 et seq.). Golden eagles and their nests also are protected under the Bald Eagle Protection Act, amended in 1973 (16 USC, § 669 et seq.).

Intensive aerial surveys were conducted during May of 1997 and 1998 to identify and locate raptor nests within the Project Area. These surveys located a total of 140 raptor nests that were encompassed by the North and South areas and pipeline corridor or within ½ mile of their boundaries. Twenty-nine and 111 of the 140 raptor nests were encompassed by, or within ½ mile of, the North and South areas, respectively. One golden eagle nest located in the South Area also is within the proposed pipeline corridor or within ½ mile of the corridor. Most of these nests are located along the pediments which trend northeast-southwest through the western portion of the Project Area.

Most of the nests (68 percent) were associated with golden eagles (**Table 3–19**). Fourteen (10 percent) were those of unidentified falcons, five (4 percent) were those of prairie falcons, five (4 percent) were peregrine falcons, five (4 percent) were red-tailed hawks, and the other fourteen (10 percent) were unidentified. Additionally, 69 (50 percent) were tended or active for at least some time during the 1997 or 1998 nesting seasons, or both.

3.7.2.3 Upland Game

3.7.2.3.1 Chukar

Chukars inhabit areas of rocky, grassy, or brushy slopes and creek bottoms in the mountains and rugged canyons of the desert. In 1996, Carbon and Emery counties represented 2.10 and 2.97 percent of the chukar harvest in the state, respectively (Mitchell et al. 1996). Long-term harvest and production trends suggest chukar populations are relatively stable in Utah (BLM 1997c). However, brood surveys suggest brood production in 1996 was slightly below average (Mitchell et al. 1996). No critical chukar habitat has been identified within the Project Area.

3.7.2.3.2 Ring-necked Pheasant

Ring-necked pheasants occur in open country, cultivated areas, wet meadows, riparian areas, and overgrown weedy ditches and fields. Statewide 1996 pheasant roadside counts were above 1995 counts, however, hens appeared to have fewer young. In 1996, Emery and Carbon counties represented 4.31 and 2.16 percent of the state's total pheasant harvest, respectively (Mitchell et al. 1996). Statewide pheasant harvests are decreasing in population due to the loss, degradation, and fragmentation of habitats (Mitchell et al. 1996).

Table 3–19
Number and Status of Raptor Nests Within the Project Area

	North Area			South Area			Pipeline Corridor		
	Total			Total			Total		
Species	No.	Percent	Number Active/ Tended	No.	Percent	Number Active/ Tended	No.	Percent	Number Active/ Tended
Falcon	6	20.7	5	8	7.2	6	-	-	-
Golden Eagle	14	48.3	5	81	73.0	34	1[a]	100	1
Peregrine Falcon	1	3.4	1	4	3.6	4	-	-	-
Prairie Falcon	1	3.4	1	4	3.6	4	-	-	-
Red-tailed Hawk	3	10.4	1	2	1.8	1	-	-	-
Ferruginous Hawk	2	6.9	-	-	-	-	-	-	-
Unidentified	2	6.9	1	12	10.8	6	-	-	-
Total	29	100	14	111	100	55	1	100	1

Note:
a This nest also is in the South Area

3.7.2.3.3 Desert Cottontail

Within this portion of Utah, desert cottontails inhabit desert and submontane habitats especially sagebrush grass lands and agricultural lands. In 1996, Carbon and Emery counties accounted for 5.92 and 5.64 percent of the state's harvest of desert cottontails, respectively (Mitchell et al. 1996). Within Utah, the population of desert cottontails is still below the 1988 high. This decline is due to the severe winter of 1992–93 and seven years of drought conditions (BLM 1997c). However, 1996 roadside counts suggest the population density has increased from 1995.

3.7.2.3.4 Mourning Doves

The mourning dove is a common spring and fall migrant and summer resident in the Project Area. Because mourning doves are able to adapt to a wide variety of habitats, they may occur in all vegetation types present in the Project Area, including coniferous forests, residential areas, and agricultural areas. Mourning doves' needs include trees in proper relation to open areas for nesting and roosting, a combination of wild and cultivated foods for feeding, and a source of water. Weed patches and grains in proximity to nesting and roosting cover provide excellent food. The mourning dove is a highly popular game bird. Due to this popularity, UDWR tracks mourning dove hunter success, distribution of harvest, and hunting pressure. UDWR's most recent summary of these parameters suggests Carbon and Emery counties account for about 4 percent of Utah's total 1996 harvest of mourning doves (Mitchell et al. 1996). In 1996, abut 200,000 mourning doves were harvested in Utah.

3.7.2.4 Furbearers/Predators

Furbearers and predators expected to occur within the Project Area include coyotes, skunks, bobcats, raccoons, and fox. These species are expected to occur through out both the North and South Areas and some species may be locally abundant. Mountain lions occur within rough habitats in the foothill and canyon country. Lions are closely associated with mule deer, which is their principle prey species. Consequently, critical habitats for the lion are considered to overlap with the crucial and high priority ranges delineated for mule deer in the Project Area.

3.7.2.5 Small Mammals

Small mammal species occurring within the Project Area probably include the deer mouse, least chipmunk, Richardson's ground squirrel, Belding ground squirrel, and bushy-tailed woodrat. Small mammal species are expected to occur within all habitat types within both the North and South Areas.

3.7.2.6 Waterfowl and Shorebirds

Within the Project Area, Huntington Lake, which is in the northeast portion of the South Area, comprises the largest single area of habitat for waterfowl and shorebirds. However, waterfowl and shorebirds also use small ponds and irrigation ditches that are scattered across private and Federal lands within the Project Area. Waterfowl species expected to occur include northern pintails, mallards, snow geese, American widgeon, and common and red-breasted mergansers. Shorebird species may include greater and lesser yellowlegs, red-necked phalaropes, short-billed dowitchers, and least sandpipers (BLM 1997c).

3.7.2.7 Songbirds

Numerous songbirds occur within the Project Area. Species anticipated to occur include the chipping sparrow, rock wren, canyon wren, scrub jay, American robin, black-billed magpie, yellow warbler, and western flycatcher. The density and number of songbirds vary by vegetation type and season.

3.7.2.8 Reptiles and Amphibians

Numerous species of reptiles and amphibians occur within the Project Area. Amphibian species, such as the tiger salamander, red-spotted toad, Woodhouse's toad, and northern leopard frog, are expected to occur within riparian and wetland habitats. Reptile species, including night snakes, western terrestrial garter snakes, western rattlesnakes, and pine snakes, are expected to occur within drier habitats in the Project Area.

3.8 SPECIAL-STATUS SPECIES

This section discusses species that have a special-status designation associated with them. This special-status designation includes:

- species listed as threatened or endangered, proposed for listing as threatened or endangered, or considered as a candidate for listing as threatened or endangered by the USFWS,
- species listed as sensitive by the BLM or Forest Service, and
- species listed as threatened, endangered, or a species of special concern by the State of Utah.

Initially, 61 species with one or more of these special-status designations were considered in this analysis. They included 17 species of plants, 1 species of reptile, 9 species of fish, 23 species of birds, and 11 species of mammals (**Table 3–20**). An initial evaluation of the species suggested the presence of 13 of the 61 species is unlikely due to a lack of potentially-suitable habitats or the Project Area is not within the species' range (**Table 3–20**). These species were not considered further in the analysis. The other 48 species that have at least some potential to occur in the Project Area were evaluated and are discussed below.

3.8.1 Special-Status Plant Species

3.8.1.1 Creutzfeldt-flower

Creutzfeldt-flower is a member of the Borage family and is endemic to central Utah in Carbon and Emery counties. Like many members of Cryptantha, the creutzfeldt-flower is a perennial with salverform (trumpet shaped) white flowers that are produced from late April to June. It is distinguishable by its narrowly spatulate to oblanceolate leaves that, while glabrous above, have undersides covered with appressed bristles that are blistered at the base.

Potentially-suitable habitats for this species are defined as shadscale and mat atriplex communities on the Mancos Shale Formation between 5,250 and 6,495 feet. Seven occurrences of Creutzfeldt-flower were located in the South Area during surveys conducted in 1997 (Intermountain Ecosystems 1997). Four occurrences were found around Rowley Flats, one of which was the largest and most contiguous occurrence. Two occurrences were north and south of Buzzard Bench. Finally, a small population was found at Diversion Hollow. The total number of individuals at all seven locations was about 14,000.

Table 3–20
Summary of Special-Status Species

Common Name	Scientific Name	Lifeform [1]	USFWS Status[2]	BLM Sensitive	Forest Service Sensitive	Utah State Status[2]	Occurrence in Project Area[3]
Graham beardtongue	*Penstemon grahamii*	P	C				1
Barneby reed-mustard	*Schoenocarmbe barnebyi*	P	E				1
Jones cycladenia	*Caclyadenia humilis* var. *jonesii*	P	T				1
Last chance townsendia	*Townsendia aprica*	P	T				1
Maguire daisy	*Erigeron maguirei*	P	E				1
San Rafael cactus	*Pediocactus despainii*	P	E				2
Winkler cactus	*Pediocactus winkleri*	P	T				3
Wright fishhook cactus	*Sclerocactus wrightiae*	P	E				2
Creutzfeldt-flower	*Cryptantha creutzfeldtii*	P			✓	S	3
Low hymenoxys	*Hymenoxys depressa*	P				S	2
Canyon sweetvetch	*Hedysarum occidentale* var. *canone*	P			✓		3
Silver milkvetch	*Astragalus subcinereus* var. *basalticus*	P				S	2
Smith wild buckwheat	*Eriogonum corymbosum* var. *smithii*	P				S	1
Mussentuchit gilia	*Gilia tenuis*	P				S	1
Jones indigo bush	*Psorothamnus polyadenius* var. *jonesii*	P				S	1
Psoralea globemallow	*Sphaeralcea psoraloides*	P				S	2
Alcove bog orchid	*Habenaria zothecin*	P				S	1
Utah milk snake	*Lampropeltis triangulum pleuriticus*	R				S	2
Bonytail chub	*Gila cypha*	F	E			E	4
Colorado squawfish	*Ptychocheilus lucius*	F	E			E	4
Humpback chub	*Gila cypha*	F	E			E	4
Razorback sucker	*Xyrauchen texanus*	F	E			E	4
Roundtail chub	*Gila robusta*	F				T	4
Leatherside chub	*Gila copei*	F				S	1
Flannelmouth sucker	*Catostomus latipinnis*	F				S	3
Bluehead sucker	*Catostomus discobolus*	F				S	3
Colorado River cutthroat trout	*Oncorhynchus clarki pleuriticus*	F			✓	S	4
White-faced ibis	*Plegadis chihi*	B					5

Table 3–20 (continued)
Summary of Special-Status Species

Common Name	Scientific Name	Lifeform [1]	USFWS Status[2]	BLM Sensitive	Forest Service Sensitive	Utah State Status[2]	Occurrence in Project Area[3]
Osprey	*Pandion haliaetus*	B				S	5
Northern goshawk	*Accipiter gentilis*	B			✓	S	2
Ferruginous hawk	*Buteo regalis*	B				T	3
Swainson's hawk	*Buteo swainsoni*	B				S	2
Bald eagle	*Haliaeetus leucocephalus*	B	T			T	3
Peregrine falcon	*Falco peregrinus*	B	E			E	3
Snowy plover	*Charadrius alexandrinus*	B					5
Mountain plover	*Charadrius montanus*	B				S	5
Long-billed curlew	*Numenius americanus*	B				S	5
Black tern	*Chlidonias niger*	B				S	5
Caspian tern	*Sterna caspia*	B				S	5
Yellow-billed cuckoo	*Coccyzus americanus*	B				T	2
Short-eared owl	*Asio flammeus*	B				S	2
Burrowing owl	*Athene cunicularia*	B				S	3
Bewick's wren	*Thryomanes bewickii*	B					2
Loggerhead shrike	*Lanius ludovicianus*	B					3
Common yellowthroat	*Geothlypis trichas*	B					2
Yellow-breasted chat	*Ichteria virens*	B				S	2
Grasshopper sparrow	*Ammodramus savannarum*	B				S	2
Lark bunting	*Calamospiza melanocorys*	B					5
Brewer's sparrow	*Spizella breweri*	B					2
Dwarf shrew	*Sorex nanus*	M				S	2
Spotted bat	*Euderma maculatum*	M			✓	S	3
Small-footed myotis	*Myotis leibii*	M				S	2
Fringed myotis	*Myotis thysanodes*	M				S	2
Townsend's big-eared bat	*Plecotus townsendii*	M			✓	S	2
Big free-tailed bat	*Nyctinomops macrotis*	M				S	2
Brazilian free-tailed bat	*Tadarida brasiliensis*	M				S	2

Table 3–20 (continued)
Summary of Special-Status Species

Common Name	Scientific Name	Lifeform [1]	USFWS Status[2]	BLM Sensitive	Forest Service Sensitive	Utah State Status[2]	Occurrence in Project Area[3]
Ringtail	*Bassariscus astutus*	M				S	3
Black-footed ferret	*Mustela nigripes*	M	E			E	1
Northern river otter	*Lutra canadensis*	M				S	1
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*	M				S	1

Notes:

1. B=bird, M=mammal, P=plant, R=reptile.
2. E=endangered, PE=proposed endangered, T=threatened, C=Candidate, S=species of special concern.
3. 1. Species presence unlikely due to lack of potentially-suitable habitats or the Project Area is not within the species' range.
   2. Potentially-suitable habitats occur or may occur in the Project Area. However, the species' presence has not been confirmed or documented.
   3. Potentially-suitable habitats are present in the Project Area and the species' presence in or near the Project Area has been confirmed and documented.
   4. Species presence in the Project Area's streams has not been confirmed or documented, but it may occur in potentially-suitable habitats upstream or downstream of the Project Area.
   5. Species may migrate through the Project Area.

Sources: Harris 1997, UDWR 1997

3.8.1.2 Low hymenoxys or Depressed bitterweed

Low hymenoxys or depressed bitterweed (Hymenoxys depressa) is a member of the Composite family and is endemic to Utah in Emery, Duchesne, Wayne, Garfield, and Sevier counties. Like most members in Hymenoxys, low hymenoxys is a perennial herb with a taproot that produces yellow ray and disk flowers. The plant is distinguishable by the several characteristics. Most apparent is its caespitose form and solitary flower heads, which are subtended by long, villous green involucres 4 to 6 millimeters wide. Also of note, the caudex branches of low hymenoxys are clothed with a marcescent thatch of erect to ascending leaf bases, and the leaves are linear, with sharp apical points. Low hymenoxys blooms from late May to June.

Potentially-suitable habitats for this species are defined as ephedra, sagebrush, shadscale and pinyon-juniper communities on fine silty clay to clay loam soils between 4,400 to 7,120 feet in elevation. Consequently, the sagebrush/grassland and pinyon-juniper vegetation types within the Project Area may provide potentially-suitable habitats for the low hymenoxys.

3.8.1.3 Canyon sweetvetch or Coal sweetvetch

Canyon sweetvetch, also referred to as Coal sweetvetch or western sweetvetch, is a member of the Pea family and is endemic to Carbon, Emery and Duchesne counties. Like most sweetvetch, canyon sweetvetch is a perennial herb that produces inflorescence that extend from the axils and fruits that are constricted between the seeds (a loment). The flowers are pink to red-purple, blooming in late June-mid-August, and the wing-like petals of the flower are shorter than the keel. Canyon sweetvetch is distinguishable from other species primarily by its more robust habit, and by its leaflets, which are decidedly obtuse, have readily visible veins, and are notched at the apex.

Potentially suitable habitat for this species is defined as pinyon-juniper and sagebrush communities between 5,000 and 8,000 feet in elevation. Four occurrences of the canyon sweetvetch were found in the South Area during surveys conducted in 1997 (Intermountain Ecosystems 1997). It was very abundant along streambanks and shaded draws in pinyon-juniper and shrub vegetation types. It was found in association with shaded, intermittent or perennial streams between 6,000 and 7,000 feet from just north of Huntington Creek south and west to Cottonwood Creek.

3.8.1.4 San Rafael Cactus

San Rafael or Despain cactus is a member of the Cactus family and is endemic to Central Utah in Emery County. This species of cactus is a small, depressed, hemispheric plant approximately 3.8 to 6 centimeters tall. Its pale yellowish spines are more than 4 millimeters long and are not obscured by the woolly pale yellowish caducous hairs. The plant blooms late April to early May, producing yellowish to peach colored flowers. While visible during this period, the San Rafael cactus is imperceptible during the rest of the year because most or all of the plant shrinks below ground surface.

Potentially-suitable habitats for this species are defined as open pinyon/juniper community on limestone gravels at 6,000 to 6,200 feet.

3.8.1.5 Winkler cactus

Winkler cactus is a member of the Cactus family and is endemic to Central Utah in Emery County. On August 20, 1998, the USFWS listed the cactus as a threatened species. The Winkler cactus has a similar range and morphology to the San Rafael cactus, so much so that there is doubt as to whether or not the two can be considered separate species. Ken Heil is currently conducting DNA studies on Pediocactus spp. to determine if *P. winkleri* and *P. despainii* are separate species.

Seven occurrences of the cactus were found in the South Area during the 1997 survey (Intermountain Ecosystems 1997). The occurrences extended from West Clawson Reservoir south to Diversion Hollow. The total number of individuals at all seven locations was probably between 500 and 1,000. These several populations of cactus have been tentatively identified as Winkler cactus.

As with the San Rafael cactus, the Winkler cactus essentially is visible during late April and early May only when environmental conditions are appropriate for flowering. During the rest of the year and when environmental conditions during late April and early May are not appropriate for flowering, the Winkler cactus is imperceptible because most or all of the plant shrinks below ground surface.

3.8.1.6 Wright fishhook cactus

Wright fishhook cactus is a member of the Cactus family and is endemic to Emery and Wayne counties, Utah. Like other members in Sclerocactus, this species is a perennial with thick succulent spiny stems. Depressed and hemispheric in shape, this genus earns its name from its hooked spines. Its identifying characteristics are the length of its spines (short) and the color and size (2 to 3.5 centimeters long) flowers. Except during its flowering period (April through May), Wright fishhook cactus is not identifiable in the field because its identifying characteristics key on the blooms.

Potentially-suitable habitats for this species are found on the Mancos Shale Formation from 4,790 to 6,120 feet in communities ranging from the salt desert shrubland to pinyon/juniper.

3.8.1.7 Silver milkvetch or Basalt milkvetch

Silver milkvetch is a member of the Pea family. It is endemic to eastern Sevier County, western Emery County, and, possibly, Bryce Canyon National Park. Like many members of Astragalus, silver milkvetch has alternate leaves that are odd-pinnately compound and its flowers are born on axillary racemes. Furthermore, the keels of the flowers are blunted instead of beaked. Silver milkvetch is distinguishable by several characteristics. Its yellowish flowers are 8.5 to 11 millimeters long and suffused with purple; its pods are 3.5 to 5.5 millimeters wide at maturity; and its leaflets are elliptic-oblong to oblong. Silver milkvetch flowers from May through July.

Potentially-suitable habitats for this species are pinyon-juniper and ponderosa communities between 4,520 and 7,970 feet in elevation.

3.8.1.8 Psoralea globemallow

Psoralea globemallow is a member of the Mallow family and is a Colorado Plateau endemic found in the southwestern Emery and Wayne counties. Like all globemallows, Psoralea globemallow is a perennial herb with stellate hairs and reddish orange flowers. This species is distinguishable from other members of the genus by its trifoliate or simple and entire lower leaves and yellowish canescent erect stems.

Potentially-suitable habitats for this species are zuckia-ephedra communities on saline and gypsiferous Entrada siltstone, between 4,000 and 6,000 feet of elevation.

3.8.1.9 Alcove bog-orchid

Alcove bog-orchid is a member of the Orchid family and is endemic to Emery, Garfield, San Juan, Grand and Uinta counties, Utah, and Moffat County, Colorado. Like all members of the bog orchid family, the Alcove bog orchid is a glabrous perennial that produces small flowers in a spike-like raceme. The flowers of this family are distinctive, producing a two lipped corolla that supinates or twists upside down upon opening. Its solitary erect stem is surrounded by sheathing basal and cauline leaves. The Alcove bog orchid is distinguished from other species in the Habenaria family by its spur-like petal, which is 1.5 to 2 times as long as its lip. This species blooms from late July to August.

Potentially-suitable habitats for the Alcove bog orchid are restricted to the moist environments scattered in the desert shrub and oak brush communities, such as seeps, hanging gardens and stream areas. Elevational range is approximately 4,360 to 8,690 feet.

3.8.2 Special-Status Wildlife Species

3.8.2.1 Bald Eagle

The Project Area supports a population of wintering bald eagles. One known nest is located outside the Project Area. The mule deer winter range provides a good forage base for the wintering bald eagles.

Eagles are expected to winter within areas of suitable habitat within the Project Area. Feeding areas, diurnal perches, and night roosts are fundamental elements of bald eagle winter range. Although eagles can fly as far as 24 kilometers (15 miles) to and from these elements, they primarily occur where all three elements are available in comparatively close proximity (Swisher 1964).

Food availability is probably the single most important factor affecting winter eagle distribution and abundance (Steenhof 1978). Fish and waterfowl are the primary food sources where eagles occur along rivers, lakes, streams, and dams. Waterfowl, such as dead, sick, or crippled individuals are often taken when fish are not readily available (Shickley 1961 and Spencer 1976). Eagles are often attracted to wintering concentrations of waterfowl. In some regions, such as Utah, carrion can also be an important food source.

Observations indicate perch sites usually must have three properties before they attract eagles. First, they must be in plain view of potential food sources. Second, they are largely within 160 feet (50 meters) of water, (Vian 1971 and Stalmaster et al. 1979). Finally, perches are usually in areas that are free from human disturbance.

Roosts may be used by individual birds or small to large groups of birds. Also, roosts can be used in successive years. Large, live trees of dominant or co-dominant species that occur in sheltered areas (e.g., in the protected slopes of a valley or ravine or behind a bluff) are preferred (Lish 1975).

Nest sites are the primary habitat feature important to breeding eagles. Although nests are usually located in trees, they can also occur on the ground or on cliff ledges. Eagles prefer to nest in live trees and construct the nest just below the top of the tree (Todd 1979). Nests can be found in any tree large enough to hold a nest. Nests are also usually close to water and food sources. Good visibility from the nest and a clear flight path to and from the nest are essential requirements (Grubb 1976).

Within Utah, the presence of only four bald eagle nests has been documented. These nests are located in riparian habitats along the Colorado and Jordan rivers and in a shelterbelt near the town of Castle Dale (UDWR 1997). The nest near Castle Dale is about two miles east of the South Area's boundary. This nest was active in 1997 and 1998.

3.8.2.2 Peregrine Falcon

Peregrine falcons occupy a wide variety of habitats. They are typically associated with open country near rivers, marshes, and coasts. Cliffs are the preferred nesting substrate, however, tall man-made structures (i.e.: high rise buildings and towers) may be used (Spahr et al. 1991).

Breeding begins in March when males establish territories. Three to four eggs are laid in mid-April. Incubation lasts from 33 to 34 days. The young hatch in mid-May. Young generally fledge in 6 weeks and remain dependent on the adults for several weeks (Spahr et al. 1991).

Peregrines typically prey on birds such a waterfowl, shorebirds, grouse, and pigeons. Prey is taken by striking from above after a high speed dive. Foraging occurs within 10 miles of the nest, however, 80 percent occurs within a one mile radius of the nest (Spahr et al. 1991).

Peregrine falcons usually migrate to Mexico or Central America in the fall. However, some birds may stay on their breeding grounds year-round if food supplies are available (Spahr et al. 1991).

Although peregrine populations are currently recovering within the Colorado Plateau region of Utah, the northern Wasatch portion has not reestablished a self-sustaining population (UDWR 1997). The presence of one peregrine nest has been documented within ½ mile of the South Area's boundary. However, this nest was not active during the 1997 breeding season. A second peregrine nest also was identified, but its location is more than one-mile outside the South Area.

Two additional falcon eyries were found within and near the Project Area during the 1998 raptor survey flights. One active eyrie was found just outside of the North Area boundary.

3.8.2.3 Black-footed Ferret

Black-footed ferrets are primarily nocturnal animals that are nearly always associated with prairie dogs. Prairie dogs are the ferret's source of prey and the prairie dogs' burrows provide dens and rearing areas for the ferret's young. A single white-tailed prairie dog colony of 200 acres (80 hectares) or a complex of smaller colonies occurring within a circle with a 4.3-mile (7-kilometer) radius that totals 200 acres (80 hectares) is considered to be the minimal size necessary to constitute potential habitat for the black-footed ferret (USFWS 1989). For black-tailed prairie dogs, the minimum colony size suitable for ferrets is 80 acres (32 hectares).

The historic range of the ferret encompasses both the North and South Areas. However, no observations of ferrets within the Project Area have been documented. The Utah Natural Heritage Program has documented three sightings near the Project Area. One sighting occurred in 1966 northeast of Price, but may have been a domestic ferret. Three were reported between Price and Huntington near Highway 10 in 1984. Two were reported northwest of Wellington in 1984. Surveys conducted for the Price CBM Project Area in 1995 did not find ferrets (BLM 1997c).

No prairie dog colonies have been identified on BLM lands within the North or South Areas. However, prairie dog colonies do exist on private lands within the South Area (Ludington 1997).

3.8.2.4 Spotted bat

Spotted bats occur in a variety of vegetation types. These types range from ponderosa pine and spruce-fir forests to deserts. Spotted bats range from Idaho and Montana to Queretaro, Mexico. Within Utah, they have been found in a variety of vegetation types, including open ponderosa pine, desert scrub, pinyon-juniper, and pastures. They typically roost singly in crevices in steep cliff faces.

In 1997 a bat study was conducted on the Manti-La Sal National Forest immediately northwest of the South Area. The results of this survey suggested spotted bats were widely distributed, although in low densities, throughout the study area (Sherwin et al. 1997). Based on this study, the spotted bat is anticipated to occur within areas of suitable habitat within the Project Area.

3.8.2.5 Big free-tailed bat

The big-free-tailed bat inhabits caves and mines in southern Utah where it forms maternity colonies. The southern two-thirds of the state contains the northern most extension of this species range, however, they are very rare within the state. No big free-tailed bats were observed during the 1997 Manti-La Sal bat study (Sherwin et al. 1997). However, they may occur within areas of suitable habitat in the Project Area.

3.8.2.6 Fringed Myotis

The fringed myotis typically occurs in areas of ponderosa pine, pinyon-juniper, saltbush, scrub oak, and greasewood. This non-migratory bat generally roost in rock crevices, caves, mines, buildings, and trees (Colorado Division of Wildlife [CDOW] 1984). Foraging typically occurs over water courses, above the shrub canopy, and in woodlands. The diet consists of moths, beetles, and spiders (CDOW 1984). No fringed myotis were observed during the 1997 Manti-La Sal bat study (Sherwin et al. 1997). However, they may occur within areas of suitable habitat in the Project Area.

3.8.2.7 Small-footed myotis

Small-footed myotis roost in crevices and cavities of cliffs and rocks, as well as caves and mines. Within Arizona they have been found from the hot deserts to the lower edge of the oak belt (Hoffmeister 1986). No small-footed myotis were observed during the 1997 Manti-La Sal bat study (Sherwin et al. 1997). However, they may occur within areas of suitable habitat in the Project Area.

3.8.2.8 Townsend’s big-eared bat

The Townsend’s big-eared bat occurs in a wide variety of habitats which include juniper/pine, shrub/steppe grasslands, deciduous, and mixed coniferous forests. They may also be found at elevational ranges from sea level to 10,000 feet (CDOW 1984). These non-migratory bats hibernate from October to February in a variety of places. The hibernaculm vary from caves, old mine shafts, rocky outcrops, and abandoned buildings (CDOW 1984).

This species is one of the most common bats found in caves and abandoned mines within Utah. The presence of Townsend’s big-eared bats in the town of Ferron was documented during late summer in 1992 (Forest

Service, no date). They have also been found using inactive coal mines as hibernacula on the Ferron Ranger District (Forest Service, no date). However, in a 1997 bat study conducted on the Manti-La Sal National Forest immediately northwest of the South Area, no Townsend's big-eared bats were located (Sherwin et al. 1997).

3.8.2.9 Brazilian free-tailed bat

The Brazilian free-tailed bat is a migratory species that inhabits the southern portion of the state. They typically form large maternity colonies in caves and mines. No Brazilian free-tailed bats were observed during the 1997 Manti-La Sal bat study (Sherwin et al. 1997). However, they may occur within areas of suitable habitat in the Project Area.

3.8.2.10 Dwarf shrew

Dwarf shrews typical inhabit talus slopes, and rocky areas within the higher mountains and may occur in subalpine meadows within the spruce-fir belt (Hoffmeister 1986). Within Utah this species is only found in the southeastern portion of the state. This species may occur within the spruce-fir and mountain fir vegetation types of the Project Area.

3.8.2.11 Ringtail

Ringtails are most commonly associated with rocky, boulder-strewn riparian areas. In general, these areas are within one quarter mile of a water source. Ringtails are known to utilize riparian habitats within the Project Area.

3.8.2.12 Ferruginous hawk

Ferruginous hawks forage in areas of little or no vegetation cover. Extensive wooded and mountainous areas are avoided. Nests may be located in bushes, junipers, or sagebrush in relatively open areas. Ground nests are typically located on hillsides, rocky outcrops, low ledges, rockpiles, erosional remnants, low cliffs, buttes, rocky pinnacles, and river cutbanks. The birds return to breeding areas in late February and early March.

The presence of active nests within the North or South Areas has not been documented. However, five nests occur in the pipeline corridor or within ½ mile of its boundary. One abandoned nest was observed in the South Area, but no individuals were observed in conjunction with this nest (Ludington 1997).

3.8.2.13 Mountain plover

Mountain plovers utilize high, dry, shortgrass prairies. Within these habitats, areas of blue gramma and buffalograss are most often utilized. In addition, areas of mixed grass associations dominated by needle-and-thread and blue gramma are also utilized (Armbruster 1983).

Nests consist of a small scrape on flat ground in open areas. Most nests are placed on slopes of less than 5 degrees, and occur in areas of buffalo grass, blue gramma, scattered cacti, and western wheatgrass. These areas typically support vegetation that is less than 3 inches tall in April (Armbruster 1983).

A small population of plovers is known to occur within the Uinta Basin. However, its status elsewhere in the state is not known. Therefore, this species may utilize suitable habitats within the Project Area.

3.8.2.14 Long-billed curlew

Long-billed curlew nest in the upland meadows and rangelands of northern and central Utah. Foraging typically occurs in moist meadows and upland habitats. This species may occur within suitable habitats within the Project Area.

3.8.2.15 Northern goshawk

Northern goshawks occur in a variety of habitats, depending on the time of the year. During the breeding season, they are primarily associated with dense forests. During the non-breeding season, use of habitats is more varied and may include coniferous forests, riparian areas, and sagebrush shrublands (Johnsgard 1986).

Nest sites are generally in mature coniferous, mixed hardwood, and deciduous forests with a closed canopy. Typically, nest trees are in the oldest stands of an area which exhibit a high tree density. Of secondary importance for nest tree location is slope, most nests are on moderate to flat slopes (0 to 30 percent) with a NE to NW exposures of in canyons protected by such slopes (Reynolds et al. 1992). There is also some preference for nesting near water (Fowler 1988). Nests are generally occupied from early March through late September (Reynolds et al. 1992).

Foraging habitat for nesting goshawks usually consists of woodlands with large, mature trees. However, goshawks are characteristically opportunistic foragers and may use deep forests as well as forest edges. Goshawks forage in the ground-shrub, shrub-canopy, and canopy zones of the forest. Although common prey species include both birds and small mammals, birds make up the largest portion of their diet (Fowler 1988).

Goshawks occur throughout Utah in the mature mountain forests and valley cottonwood habitats. Although the occurrence of goshawk nests within the Project Area has not been documented, a slight chance exists that they may nest in the limited spruce-fir and mountain fir vegetation types and forage in the sagebrush grassland salt desert shrub, agricultural, and wetland/riparian vegetation types within the Project Area.

3.8.2.16 Northern harrier

Northern harriers are typically ground nesters that nest in tall grass or in brush and shrubs. They generally hunt over grasslands and wet meadows. They forage on a wide variety of species ranging from birds to rodents. However, voles are the most common species taken. No harrier nests have been identified within the Project Area. However they do occur within areas of suitable habitat.

3.8.2.17 Burrowing owl

Burrowing owls are commonly associated with rodent colonies, especially prairie dog colonies. Within Utah, burrowing owls generally occur within desert valleys and grasslands that support prairie dogs. No burrowing owl populations have been identified within the Project Area, but it is likely they occur within prairie dog colonies in or near the Project Area.

3.8.2.18 Black tern

The black tern is typically associated with sloughs, marshes, and wet meadows (American Ornithologists' Union 1983). Black terns nest in either small or large marshes which contain extensive stands of emergent vegetation and some open water (Johnsgard 1986). Nests may occur on either emergent vegetation or on muskrat houses. Also some birds have been recorded to nest in mountain parks up to 8,000 feet in elevation (Rose 1993). The diet of the tern generally consists of insects (Johnsgard 1986).

Within Utah, the black tern is known to nest in wetlands associated with northern lakes such as Utah, Pelican, and Great Salt Lake. In addition to the lakes, they are also known to occur along the Green and Bear rivers. Suitable habitat within the Project Area is very limited for this species, however, they may occur seasonally.

3.8.2.19 Short-eared owl

The short-eared owl is a resident species within Utah. They are most commonly associated with central and northern wetlands and deserts within the state. No nests for this species has been identified within the Project Area, but they may occur within areas of suitable habitat.

3.8.2.20 White-faced ibis

White-faced ibises are associated with freshwater and brackish marshes. Generally these areas contain cattails, bulrushes, and phragmites (Johnsgard 1986). Typically ibises may be found foraging for insects, worms, crawfish, mollusks, small frogs, newts, and leeches along rivers, streams, and irrigated fields (Armbruster 1983). This species has not been confirmed to occur within the Project Area, but they may occur seasonally in suitable wetland habitats.

3.8.2.21 Snowy plover

Snowy plovers occur on barren sandy beaches and flats. Habitat for this species is restricted to the wetland vegetation type and, therefore, would be very limited in the Project Area.

3.8.2.22 Bewick's wren

Bewick's wrens occur in rough, low growing brushy areas that support heavy overhead cover. These areas may include riparian habitats through the sagebrush and pinyon-juniper vegetation types (Johnsgard 1986). Bewick's wrens may occur within the sagebrush grassland, riparian, and pinyon-juniper vegetation types within the Project Area.

3.8.2.23 Loggerhead shrike

The loggerhead shrike is typically associated with open vegetation types. Typically these include agricultural areas, sagebrush shrublands, desert scrub, pinyon-juniper woodlands, and montane meadows (Johnsgard 1986). This species generally hunts by perching and watching for prey. Prey species include small vertebrates, mice, snakes, and occasionally birds (Armbruster 1983). After seizing its prey this species caches it either in trees or on sharp objects including barb wire fences (Armbruster 1983).

Loggerhead shrikes were found during breeding bird surveys conducted for the Price CBM EIS immediately north of the South Area. Therefore, loggerhead shrikes are expected to occur within areas of suitable habitat throughout the Project Area.

3.8.2.24 Grasshopper sparrow

Historically, the grasshopper sparrow was abundant within the state. This species nests in semi-colonial groups in dry grasslands with mid-height to short clumps of grass with very little shrub cover. Currently, the grasshopper sparrow is only known from a few sites in northern Utah. The grasshopper sparrow may occur within the Project Area within areas of suitable habitat.

3.8.2.25 Lark bunting

This species typically occurs in short-grass and mixed-grass habitat types. They may be found in fallow fields, weedy roadsides, and hayfields. This species may occur within the agriculture vegetation type within the Project area.

3.8.2.26 Brewer's sparrow

This species is typically found in semi-desert scrub habitats. These areas may include mountain mahogany or sagebrush habitats (Johnsgard 1986). Brewer's sparrows may occur within the sagebrush and salt desert shrub vegetation types within the Project Area.

3.8.2.27 Osprey

The osprey is sparsely distributed within Utah. This species feeds almost exclusively on fish. Therefore, they are generally distributed around mountain lakes and along the Green River. The historical range has been reduced throughout the state and almost all known nesting occurs at Flaming Gorge Reservoir. Potentially-suitable habitats for the osprey are limited within the Project Area and are not expected to occur regularly.

3.8.2.28 Swainson's hawk

The Swainson's hawk is a neotropical migrant in the state of Utah. This raptor species nests in trees near open desert grasslands, shrub-steppe, and agricultural fields. They most commonly occur within the northern valleys and West Desert of Utah. Within Utah, Swainson's hawk populations have increased from 1966 to 1994. However, poisonings in South America since 1994 has decreased Swainson's populations in Utah. Swainson' hawks may occur within the agricultural, sagebrush grassland and pinyon-juniper vegetation types throughout the Project Area.

3.8.2.29 Yellow-billed Cuckoo

Within Utah the yellow-bellied cuckoo nests in localized riparian valleys through out the state. This species is declining due to a loss of habitat and urban development. The riparian vegetation type within the Project Area may support yellow-billed cuckoos.

3.8.2.30 Caspian tern

The Caspian tern occurs within Utah in association with islands, dikes, and wetlands around the Salt Lake. They may also be found near Utah Lake. Habitats for the Caspian tern is limited within the Project Area and are not expected to regularly occur.

3.8.2.31 Common yellowthroat

The common yellowthroat is a neotropical migrant to the state of Utah. They are most commonly associated with wetland and riparian habitats. Common yellow throats may occur within the limited areas of wetland and riparian vegetation types within the Project Area.

3.8.2.32 Yellow-breasted chat

Yellow-breasted chats are a neotropical migrant that inhabits riparian and wetland habitats. Although this species occurs through out the state, its decline appears to be linked to loss of habitat. Habitats are limited for the yellow-breasted chat within the Project Area.

3.8.2.33 Utah milk snake

Utah milk snakes inhabit semi-arid areas, pine forests, deciduous forests, and suburban areas. This species is nocturnal. Within Utah, the milk snake is found in the eastern and central portions of the state. This species may occur throughout the Project Area within areas of suitable habitat.

3.8.3 Special-Status Aquatic Species

3.8.3.1 Endangered Colorado River Fishes

The following four species of fish occur in the Upper Colorado River basin and are listed as endangered. The USFWS manages these species according to the "Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin" (Recovery Program). The primary concern addressed by the Recovery Program is the depletion of water from the Upper Colorado River basin. As a result of the Recovery Program's implementation, mandatory mitigation exists for depletions of water from the Upper Colorado River basin.

3.8.3.1.1 Bonytail Chub

The bonytail chub is generally associated with open water areas of large river channels. Water depths of 3 to 4 feet with uniform depth and velocity are preferred. In addition, shifting, sandy substrates are chosen. Adults most often feed on terrestrial insects that it takes from surface feeding (Behnke and Benson 1983). Adults typically do not spawn until they are 5 to 7 years old. Spawning occurs in water temperatures near 65°F during June and July (Behnke and Benson 1983). No bonytail chubs were identified during the 1997 fish surveys conducted within the Project Area. Since 1980, the nearest occurrence of bonytail chubs was in the Green River in Desolation and Cataract Canyons (Sigler and Sigler 1996). Both of these locations are at least 120 river miles downstream of the Project Area.

3.8.3.1.2 Colorado Squawfish

Adult Colorado squawfish prefer the deeper areas of river channels while, first year fish utilize quiet backwater areas and side channels (Woodling 1985). Adults generally spawn at 6 to 7 years of age. Adults are predacious and generally feed on other fishes. Spawning is thought to take place during mid-summer in water temperatures between 68° to 72°F (Woodling 1985). However, juveniles generally feed on small invertebrates (Behnke and Benson 1983). No squawfish were identified during the 1997 fish surveys conducted within the Project Area. However, squawfish have recently been found downstream of the Project Area in the Price River. They were found up to a diversion located one mile south of the town of Wellington, 88.5 miles upstream of the Green River.

3.8.3.1.3 Humpback Chub

The humpback chub is typically associated with deep, swift waters such as those found in canyons. Young humpback chubs prefer quiet backwater areas, much like that of young squawfish. The humpback feeds on invertebrates by foraging on the river bottom. However, they have also been observed to surface feed (Behnke and Benson 1983). Spawning typically occurs from May through July. Water temperatures for spawning are near 65°F. However, not much is known about the spawning habitats of the humpback.

Currently, the largest known population occurs in the Black Rocks area downstream of Grand Junction CO. Suitable habitat for the humpback chub does not occur within the Project Area and no humpback chubs were identified during the 1997 fish surveys conducted within the Project Area. The nearest recent occurrence of humpback chubs was in the Green River in Desolation, Cataract and Westwater Canyons (Sigler and Sigler 1996). These locations are at least 120 river miles downstream of the Project Area.

3.8.3.1.4 Razorback Sucker

The razorback sucker is typically associated with off channel ponds and backwater areas. In addition, eddies, backwater areas, gravel pits, flooded bottoms, and flooded mouths of tributaries are utilized (Behnke and Benson 1983). Adults generally feed on small invertebrates and algae which they remove from the substrate.

Spawning generally occurs from January and February through April. Spawning typically occurs over gravel bars, silt, cobbles, and in off channel ponds. In addition, spawning occurs when water temperatures are between 54° and 68°F and depths range from 1 to 20 feet (Behnke and Benson 1983). However, non-native fish prey upon the eggs thereby reducing reproductive success. After hatching the young prefer shallow littoral zones for the first few weeks (Behnke and Benson 1983).

The USFWS has proposed designating the Colorado River from Rifle, Colorado to Lake Powell as critical habitat for the razorback (USFWS 1993). No razorback suckers were found during the 1997 fish surveys conducted within the Project Area. They are scarce to rare in the Green River near Vernal, Utah to Lake Powell (Sigler and Sigler 1996). They historically occurred commonly in the Price river downstream of the Project Area, and have recently been found at the mouth of the San Rafael River (Berg 1997).

3.8.3.2 Sensitive Species

3.8.3.2.1 Roundtail chub

Adult roundtail chub typically occur in slow moving water adjacent to fast moving water. Generally, groups of adults occur in quiet swirling water and move into fast water to feed. Adults generally feed on aquatic and terrestrial insects; however, larger chubs will sometimes feed on other fish. The young-of-year typically prefer shallow river runs, while juveniles occur in river eddies and irrigation ditches (Woodling 1985). Spawning takes place over gravel substrates and occurs in early summer (Woodling 1985).

Within Utah, the roundtail chub is known from the Colorado River Basin main stem and its tributaries (Sigler and Sigler 1996). No roundtail chubs were found during the 1997 fish surveys although large populations were found in the San Rafael River in 1997 and are thought to occur at the mouths of Cottonwood, Huntington, and Ferron creeks (Berg 1997). They potentially still occur downstream of the Project Area in the lower Price River. However, recent surveys recorded no roundtail chubs in the Price River (Berg 1997).

3.8.3.2.2 Flannelmouth sucker

This species is endemic to the Colorado River Basin. Habitats include slow-flowing, lower gradients of larger rivers. Introduction of non-native fish species, habitat loss, and changes in flow regimes has caused a decline in populations of this species. Flannelmouth suckers were found during the 1980 UDWR electroshocking surveys within the Project Area (Cottonwood Creek). Additionally, recent studies found good populations of flannelmouth suckers from the Price River downstream of the Project Area (Masslich and Holden 1995 and Berg 1997). Although flannelmouth suckers were not found during the 1997 surveys, they probably occur in limited numbers within the Project Area.

3.8.3.2.3 Bluehead sucker

Bluehead suckers occur in fast flowing, rocky riffles in small to large rivers. Occupied habitats are generally in higher gradient reaches. Changes in flow regimes, habitat loss, and introduction of non-native fish species are the major cause of decline for this species. They are widely distributed in the Green River (Sigler and Sigler 1996). Bluehead suckers were found during the 1997 electroshocking surveys within the Project Area (Cottonwood Creek). Additionally, they have been found throughout the Price River (Berg 1997).

3.8.3.2.4 Colorado River cutthroat trout.

Historically the Colorado River cutthroat trout occurred in most waters of the upper Colorado River basin. However, competition from introduced non-native trout have reduced their numbers throughout their range. In addition, angling pressure has contributed to their decline.

The ecology of the Colorado River cutthroat is similar to that of all cutthroats, in that they occur only in cold water habitats. Generally the diet of juveniles and young cutthroats consists of insects. However, as they age they become more predaceous, forage species may include sculpins and dace (Baxter and Simon 1970). They are spring spawners that typically spawn over gravel substrates with water temperatures generally near 45°F (Woodling 1985).

No individuals of this subspecies were found during the 1997 fish surveys of the Project Area. Furthermore, they are not expected to occur downstream of the Project Area. A non-pure population of Colorado trout was recently found in Crandall Canyon, a tributary to Huntington Creek, that is upstream of the Project Area (Berg 1997).

3.9 CULTURAL RESOURCES

Cultural resources are the nonrenewable remains of prehistoric and historic human activity, occupation, or endeavors as reflected in cultural districts, sites, structures, buildings, objects, works of art and natural features that were of importance in human history and prehistory. Cultural resources are the physical remains themselves, areas where significant events occurred (even if physical evidence of the events no longer remains), and the environment surrounding the actual resources. The Utah BLM defines a cultural resource site as a discrete locus of human activity that is presumed to be interpretable.

Significant cultural resources are defined as those districts, sites, objects, or natural features that are listed on or meet the criteria for nomination to the National Register of Historic Places (NRHP). Significant cultural resources are generally more than 50 years old, retain essential integrity of location, design, setting, materials, workmanship, feeling, and association, and meet one or more of the criteria for eligibility (36 CFR § 60.4). Prehistoric sites lacking distinctive architectural or artistic elements are most often evaluated as eligible under criterion d, the potential to yield information important in prehistory. The importance of the information that a prehistoric site may be likely to yield is judged in terms of its potential contribution to widely recognized and accepted research questions. An important aspect of evaluating prehistoric sites is the element of contextual integrity or the presence of a discrete association of artifacts or features that can be meaningfully placed in a cultural historical context of age and cultural affiliation. Large quantities of data may have little or no meaning if they lack secure association or context, and cannot be placed culturally or temporally by secure association with chronometric or typologically diagnostic comparative materials. In some cases, prehistoric sites may have specific associations with important persons or events in Native American history and tradition that may make them eligible.

Historic sites can be eligible under any or all of the criteria for eligibility. Frequently, association with specific historic persons or events or outstanding artistic or architectural features are emphasized, but many historic sites also have the potential to yield important historical archaeological information. As with prehistoric sites, the context and association of the information that an historic site may yield is important in assessing the potential importance of that information.

3.9.1 Regional Overview

The Project Area spans the north end of the Castle Valley, which extends westward from the San Rafael Swell to the Wasatch Plateau. The broader region in which this is located is the Colorado Plateau southwest of the Uinta Basin. The western portions of the South Area are dominated by deep canyons and narrow mesas. East of the canyons is a broad area of pediment benches and shale flats crosscut roughly west to east by Ferron Creek, Cottonwood Creek, Huntington Creek, and numerous smaller washes. Runoff from the Wasatch Plateau provides adequate and reliable water along the major drainages, but ambient precipitation is scanty. The canyons and the principal drainages have long been focal areas for human activities. The latter circumstances have made irrigation and surface water rights very important in local history. The North Area is located on sandstone and shale benches and flats extending south from the Book Cliffs. This area is crosscut by numerous south flowing washes and gulches tributary to the Price River.

The general area that includes Castle Valley is known for numerous rock art sites and many Fremont period sites in the canyons and closely adjacent ecotone settings. The comparatively brief history of the region has been dominated by Mormon settlement beginning in the 1870s, the arrival of the railroad, coal mining made feasible by the railroad, and the development of farming and ranching. The known prehistory and history of the region has been summarized by Spangler (1993) from the perspective of research in Nine Mile Canyon to the northeast. The latter treatment is much more exhaustive than is possible within the constraints of this environmental impact document.

3.9.1.1 Prehistory

Prehistoric investigations in nearby canyon areas, such as Nine Mile Canyon have been heavily oriented to later architectural sites and to the canyon areas where rockshelters, rock art, and masonary dwellings can be found. From cultural ecological and processual perspectives, this provides a very biased sample of the prehistory of the region, and gives a very narrow perspective of potential settings for significant sites.

Spangler's (1993) overview of the Price River Resource Area, which focuses heavily on the Nine Mile Canyon area, indicates that the majority of prehistoric sites are found in the desert scrub settings with easy access to pinyon-juniper and to riparian resources. In a broader regional perspective, investigations have been more balanced.

The Paleoindian or Pre-Archaic cultural period, particularly in the perspective of Late Pleistocene big game hunters, is poorly represented on the northern Colorado Plateau, and essentially unrepresented in the Castle Valley. There may be some potential for isolated Paleoindian surface finds in the study area, but substantial areas of in situ late Pleistocene or early Holocene sediments that would be likely to yield significant buried cultural levels of this time period have not been identified.

The Desert Archaic is represented in dry cave deposits and open sites in eastern Utah. Several investigator's have suggested a northern Colorado Plateau variant of the Desert Archaic, or, possibly a distinct northern Colorado Plateau Archaic culture. Schroedl's (1976) proposed Northern Colorado Plateau Archaic sequence was based heavily on excavations in cave and canyon settings near and similar to portions of the Price River area, including Sudden Shelter. The Archaic adaptations on the northern Colorado Plateau are characterized by generalized hunting and gathering subsistence strategies that are differentiated principally by differences in projectile point types, and some variations in perishable technologies such as basketry. Those adaptations remained essentially unchanged for thousands of years until the adoption of the bow and arrow and the development of horticulture.

Around 2000 years ago, Formative horticulture is evident in the region. Some researchers have suggested a substantial hiatus between the Archaic and Formative, or the migration of new populations into the region. Transition to formative adaptations is characterized by incipient horticulture, semi-permanent dwellings, and the absence of ceramics. Cermanics become well developed in the Formative periods.

Around A.D. 700, attributes considered diagnostic of Formative culture become conspicuous in the region. These include evidence of horticulture and associated storage facilities, masonry residential architecture, rock art, and ceramics. Fremont sites are the most readily recognized archaeological manifestation in the region. It is unknown whether Fremont was an indigenous development or was introduced from elsewhere. The presence of ceramics and masonry architecture makes the identification of these sites comparatively easy. These sites have been discovered predominately in canyon and ecotone environments, but have also been identified on the shale benches and piedmont slopes around the edges of the Mancos Lowlands.

In the twelfth to thirteenth century, the sedentary Fremont horticulturalists are no longer present and are replaced by Numic groups. Historic Numic groups in the region include Ute, Shoshone, Paiute, and Goshute. This corresponds roughly to a period when southwestern populations were consolidating into fewer and larger settlements, and peripheral or marginal horticultural areas were being abandoned. Many of these areas are subsequently occupied by dispersed nomadic bands of Numic, Yuman, or Athapaskan hunter-gatherers (Lipe 1983). The post-Formative transition this being clearly Ute territory by the time of Euroamerican entry into the region.

Euroamerican contact began with the Spanish Trail, a travel route from Santa Fe through Nevada to the missions of Southern California, crossing east of the Project Area. There were no settlements or way stations established in the vicinity of the Project Area. The later Gunnison Trail followed a more northerly route in this area, passing through Woodside and north around Cedar Mountain, and then southwesterly past Castle Dale where it rejoined the old Spanish Trail (Emery County Historical Society 1981). Euroamerican contacts with the Ute in these early years were peaceful and sporadic. However, as more Euroamericans passed through the region, the Ute began to resist. Black Hawk's band and occasional parties from other bands began raiding white settlements in the mid 1860s, and cavalry and militia were mobilized to chase the Ute until Black Hawk finally withdrew to the Uinta Basin in 1867. The aridity and remoteness from major travel routes of Castle Valley were probably major factors in its late settlement, but the use of the area by Ute raiding parties in the 1860s probably contributed. The Ute bands certainly had traditional localities in this area, but the historic accounts do not provide insights into traditional settlement locations or collecting areas.

No responses have been received from Native American groups that would aid in identifying potential traditional Cultural Properties or areas of traditional Native American concern in the Project Area. Archaeological resource types likely to be present in portions of the Project Area that may be of concern to the Ute Tribe and may fit the formal legal definition of traditional Cultural Properties (Parker and King 1990) include rock art panels, mineral or stone procurement areas, vision quest sites, communal/ceremonial dance grounds, monumental stone cairns or alignments, medicinal or sacred plant gathering areas, and unmarked burials. Although none of these site types have been identified to date as traditional Cultural Properties or areas of Native American concern, these types of archaeological resources should be evaluated in keeping with NPS Bulletin 38 (Parker and King 1990).

3.9.1.2 History

The dominant economic activity in Carbon County has long been coal mining, while agriculture has also been important in Emery County. Euroamerican presence in the area had begun with transitory Spanish *entradas*, traders from New Mexico, explorers, and fur trappers. But there was no sustained Euroamerican presence in the area until the establishment of permanent Mormon settlements in the 1870s. The first Mormon settlements were in Castle Valley at Huntington, Ferron and Castle Dale, and Price was settled a short time later. The arrival of the Denver and Rio Grande Railroad in Price increased the importance of that settlement, and stimulated the further development of the coal mining town of Scofield and new settlements at Wellington and Helper. The Denver and Rio Grande Railroad was a major regional railroad that linked Castle Valley to import regional and more distant markets. However, this railroad had been preceded by smaller lines such as the Calico Railroad. Many of the early homesteads failed, and the development of coal reserves, made more feasible by the railroad, was fundamental to the area that would become Carbon County. The coal camps attracted many non-Mormon immigrants to the region. Some coal camps, notably Standardville, remained more strongly Mormon in character, but generally the region was characterized by a mix of Mormon and non-Mormon influences.

The arrival of the railroad in Utah, and the demand for coal from the precious metal mining industry were critical in the development of the coal industry in Utah, and its influences on settlement and economic development (O'Neil 1981). There are numerous traces of active and abandoned railroad grades, railroad support facilities, and features related to railroad construction scattered about the landscape. Initially amicable relationships between the railroads and the Mormons deteriorated and led to numerous conflicts and accusations. Among other sentiments, the Mormons accused the railroads of bringing in other ethnic groups and discriminating against hiring Mormons.

The railroads and development of the coal industry also stimulated ranching and farming, which remained dominant in Emery County. Ranches and farms had a large market in the local mining towns and were also provided access to larger markets by the railroads. The importance of ranching and farming encouraged the development of additional agricultural lands, and cooperative irrigation projects became an important feature of social and economic development.

3.9.2 Known Cultural Resources

In order to assess potential impacts to significant cultural resources in the Project Area, a Class I cultural resource inventory was conducted. The Class I inventory consisted of a files search at the Utah Division of State History, Salt Lake City, a files search at the BLM Price Field Office, Price, a review of pertinent regional history and prehistory, and a review of applicable theoretical and methodological literature. Locations of previous investigations and previously recorded cultural resource sites were plotted on project maps, and information was tabulated on site type, general environmental setting, cultural affiliation, and National Register evaluation/recommendation. Available ethnographies and the BLM General Land Office Historic Index were also consulted for information on the approximate locations of historic Native American camps and historic homestead entries that may not be recorded as cultural resource localities.

Over the past two decades there have been a number of cultural resource investigations in the Project Area, but only a small portion of the Project Area has been intensively investigated. The majority of past cultural resource investigations have been narrow linear corridors for seismic exploration, pipelines, transmission lines or road improvements, or small block surveys of a few acres or less for borrow pits, exploratory drill sites, gauging stations, stock ponds, and other very localized actions. Over the years, a few Class II sample studies have been conducted that have selected larger, widely scattered blocks for intensive survey (e.g., Hauck 1979 and Black and Metcalf 1986).

The Class I inventory for the Project Area indicated that 96 sites had been recorded previously in the Project Area, predominantly in Emery County. Previously recorded sites include 55 prehistoric sites, 35 historic sites, five sites with both historic and prehistoric materials, and one site that lacked materials indicative of age or had misplaced documentation. Thirty-one of the 96 sites were recommended as eligible for the National Register of Historic Places (20 prehistoric, 9 historic, and two with both prehistoric and historic materials). Fifty of the sites were recommended not eligible (27 prehistoric, 21 historic, one mixed, and one of undetermined age), and 15 sites were unevaluated (5 historic, 8 prehistoric and two mixed). **Table 3–21** gives a brief list of the previously documented cultural resources in the study area, the general site type, chronological period, if known, approximate size and National Register recommendation.

The largest class of historic sites consisted of 12 dumps and cultural material scatters lacking identifiable features or structural remnants. Other sites included four farms or ranches, seven abandoned coal mines, three irrigation canals, two isolated corrals, two temporary camps, a bridge, two isolated cabins, a road, and a rock shelter. Historic sites recommended eligible included one ranch, three canals, an abandoned mine and mine town, a road, a rock shelter, and two dump areas. Historic materials mixed with prehistoric materials included a mining camp, an historic inscription, a dump area, and two sparse cultural material scatters. None of the latter materials were considered potentially eligible.

Prehistoric sites are predominantly lithic scatters of unknown age or affiliation (n=27). Five lithic scatters with diagnostic materials included two Fremont sites, two Archaic sites, and one site with both Fremont and Archaic materials. Seven of the surface lithic scatters were considered eligible for the Register. Nine prehistoric camps and three rock shelters with prehistoric components were identified. Eight of the camps and two of the rock shelters were considered eligible. In addition, potentially eligible Fremont period sites with masonry structures were identified. The seven remaining sites included four lithic procurement or reduction areas, one hunting station, a mixed cultural material scatter (with ceramics), and an isolated hearth.

Table 3–21
Cultural Resource Sites within the Ferron Natural Gas Project Area

SITS No.	H/P	Site Type	Period	Size (m²)	Evaluation
42CB96	P	lithic scatter	unk	1,200	not eligible
42CB97	P	hunting station	unk	49	not eligible
42CB98	P	lithic scatter	unk	225	not eligible
42CB335	P	lithic scatter	unk	1	not eligible
42CB385	H	Kenilworth Mine & Townsite		>121,500	eligible
42CB533	H	irrigation canal	1887-present	27,000	eligible
42CB534	H	trash dump	1920s-1960s	12,000	eligible ?
42CB535	H	construction camp	1900s-1950s	2,200	not eligible
42CB933	H	masonry (sandstone) cabin	1900s-1950s	150	not eligible
42CB946	H	cultural material scatter	1900s-1980s	(no form)	not eligible
42CB947	H	cultural material scatter	1904-1917	20	not eligible
42CB948	H	cultural material scatter	1900s-1960s	300	not eligible
42CB949	H	cultural material scatter	1911-1917	400	not eligible
42CB950	H	cultural material scatter	1903-1917	130	not eligible
42CB951	H	cultural material scatter	1905-1916	470	not eligible
42CB1029	P	lithic scatter	unk	294	not eligible
42EM631	P	lithic scatter - deflated	unk	400	unevaluated
42EM632	P	lithic scatter	unk	110	unevaluated
42EM691	P	lithic scatter; limited activity	unk	40	unevaluated
42EM692	P	lithic scatter; limited activity	unk	10	unevaluated
42EM705	P/H	lithic scatter; crockery	unk	50	unevaluated
42EM706	P/H	lithics; glass and metal	unk	65	unevaluated
42EM763	P	lithic scatter	Fremont; Archaic	650	unevaluated
42EM764	P	lithic scatter	unk	500	not eligible
42EM765	P	lithic scatter	unk	900	unevaluated
42EM766	P	lithic scatter	Archaic	1,000	unevaluated
42EM767	P	lithic workshop	unk	1	not eligible
42EM768	P	rock shelter with lithics	unk	950	unevaluated
42EM959	P	rock shelter	unk	80	eligible
42EM960	P	rock shelter	unk	80	eligible
42EM1092	P	sandstone slab structure	Fremont	315	eligible
42EM1093	P/H	camp; dump	unk	15,700	eligible
42EM1101	P	buried hearth	unk	2	not eligible
42EM1123	P	lithic scatter	unk	15	not eligible
42EM1124	P	chipping station	unk	80	not eligible
42EM1125	?	masonry enclosure or structure	unk	15	not eligible
42EM1181	P	lithic scatter	unk	95	not eligible
42EM1182	P	small camp	Fremont	590	eligible

Table 3–21 (continued)
Cultural Resource Sites within the Ferron Natural Gas Project Area

SITS No.	H/P	Site Type	Period	Size (m²)	Evaluation
42EM1327	H	cabin	unk	25	not eligible
42EM1527	H	dump	1900s-1950s	400	eligible
42EM1638	P	camp	unk	61,820	eligible
42EM1643	P	camp	unk	30	eligible
42EM1645	P	lithic scatter	unk	1,770	eligible
42EM1646	H	rock shelter	unk	40	eligible
42EM1647	H	debris scatter; hearth	unk	4,415	not eligible
42EM1648	P	lithic scatter	unk	470	eligible
42EM1649	P	lithic scatter (dunes)	unk	7	eligible
42EM1650	P	lithic scatter (dunes)	unk	705	eligible
42EM1651	P	lithic scatter (terrace)	unk	470	not eligible
42EM1652	P	lithic scatter (dunes)	unk	160	eligible
42EM1653	H	log and pole corral	unk	400	not eligible
42EM1654	P	lithic scatter	Late Archaic?	120	eligible
42EM1658	H	pole corral	1950s - present	1,200	not eligible
42EM1659	P	lithic scatter	unk	15,000	eligible
42EM1660	P	lithic scatter	unk	20	not eligible
42EM1661	P	lithic scatter	unk	60	not eligible
42EM1662	P	lithic scatter	unk	80	not eligible
42EM1866	P	lithic scatter	Fremont	5,400	not eligible
42EM1950	P	camp	unk	315	eligible
42EM2084	P	lithic scatter	unk	3,925	not eligible
42EM2086	P	lithic scatter	Fremont?	4,400	not eligible
42EM2095	P	camp; processing locality; pit houses	Fremont	1,295	eligible
42EM2102	P	quarry; workshop	unk	5,275	not eligible
42EM2103	H	farmstead	1900s	6,000	not eligible
42EM2104	P	camp	unk	30	not eligible
42EM2108	P	lithic scatter	unk	20	not eligible
42EM2109	P	see 42EM2095 and report	Fremont	not available	not eligible
42EM2112	P	cultural material scatter	Fremont	1,250	not eligible
42EM2113	P	camp	unk	195	eligible
42EM2130	P	masonry habitations	Fremont	1,450	eligible
42EM2199	H	dump	1880s-1930s	690	not eligible
42EM2214	H	ranch complex	1890s-1950	2,400	eligible
42EM2215	H	bridge	1900-present	360	not eligible
42EM2216	H	homestead	1890-present	2,650	not eligible
42EM2248	H	coal mine	1920-1960	40,000	unevaluated
42EM2249	H	coal mine	1930-1966	40,000	unevaluated

Table 3–21 (continued)
Cultural Resource Sites within the Ferron Natural Gas Project Area

SITS No.	H/P	Site Type	Period	Size (m^2)	Evaluation
42EM2250	H	coal mine	1932-1958	1,200	unevaluated
42EM2284	H	coal mine	1922-?	550	unevaluated
42EM2285	H	coal mine	1922-?	100	unevaluated
42EM2317	P	lithic scatter	unk	60	not eligible
42EM2402	P/H	lithic scatter; mining camp	unk	180	not eligible
42EM2403	P	lithic scatter	unk	4,700	not eligible
42EM2421	P	lithic scatter	unk	690	not eligible
42EM2422	P/H	camp; inscription	Early Archaic; Fremont	865	eligible
42EM2423	H	road	1876-1949	not applicable	eligible
42EM2431	H	homestead	1910s-1920s	227,500	not eligible
42EM2433	H	canal system	1884-present	4,830	eligible
42EM2445	H	canal	1884-present	380	eligible

SITS: Smithsonian Institution Trinomial System official site number

The records search for the Project Area also included a search of the Historic Index and an inspection of General Land Office plat maps at the BLM State Office. Homestead entries, Desert Land Act entries, Enlarged Homestead entries, Stock Raising Homestead entries, cash entries, and patents were tabulated for the Project Area. Public sales, mineral entries, ditch and canal easements, and railroads easements or grants were also noted but not tabulated in detail. The general location of former entries and patents were plotted on Project Area maps, patterns were noted for numbers of entries by five-year periods, and the proportion of the entries that were canceled or relinquished.

As would be expected, entries and patents were strongly clustered around principal drainages and nearby irrigation benches. Early homestead entries in the late 1870s and the early 1880s are sparse with most lands being claimed by Mormon settlements. In the mid 1880s, entries became increasingly common, and continue at a moderate rate in most of the principal drainage valleys until the 1920s. However, except for the period from 1900 to 1905, the vast majority of entries are canceled or relinquished and fail to obtain land patents.

A significant proportion of the various homestead entries in the Historic Index are listed as canceled or relinquished within ten years. Many of these brief and unsuccessful homesteads would have left little in the way of cultural remains or landscape modifications, but nonetheless reflect a focus of settlement and land use along the principal drainages. Beginning in the 1920s in several areas and increasing in frequency in the 1950s throughout much of the Project Area, mineral entries, oil and gas leases, and coal leases come to dominate the records in the Historic Index.

3.10 LAND USE

The principal land uses in the Project Area include range, agriculture, residential, coal mining, oil and gas development and utility corridors. Current land use and land ownership in the Project Area and vicinity were mapped and tabulated utilizing BLM 1:100,000 Surface Management Status maps, BLM Master Title Plats, BLM Oil and Gas Plats, BLM Coal and Potash Plats and aerial photos. In addition, current and proposed land management plans for the area and their constraints were identified.

3.10.1 Land Status/Ownership

Approximately 61 percent of Carbon County and 92 percent of Emery County is public land. Most of the public land is federal land administered by the BLM and U.S. Forest Service land in the Manti-La Sal National Forest. State-owned and private lands account for the remainder.

Land ownership within the Project Area is primarily BLM-administered federal land, interspersed with blocks of state-owned lands and private lands.

The Manti-La Sal National Forest adjoins the west side of the South Area and is also incorporated in the western edge of the South Area. State-owned lands consist of lands administered by the State Institutional Trust Lands Administration, the Utah Division of Sovereign Lands and Forestry, and the Utah Division of State Parks. Part of the Huntington Lake State Park is within the South Area. The distribution of land ownership in the North and South Areas is summarized in **Table 3–22** and shown on **Plate 2–1**. The pipeline corridor is located primarily on private lands and BLM in Emery County.

3.10.2 Land Use

Several primary land uses occur within the Project Area. The following sections identify and describe each use. **Plate 3–7** show the distribution of these land uses in the Project Area.

3.10.2.1 Agriculture/Range

Agriculture is second in importance to coal mining in Carbon and Emery Counties. Most agricultural lands in the counties are used for livestock operations. Grazing occurs in both the North and the South Areas, and along the pipeline corridor in Emery County. Irrigated croplands occur in the South Area.

Table 3–22
Land Ownership in the Project Area

	Areal Extent (acres)				
Area	BLM	Forest Service	State of Utah	Private	Total
North Area	12,591	0	2,935	2,824	18,350
South Area	31,649	10,976	25,106	25,439	93,170
Pipeline Corridor[1]	58	0	2	201	262
Total	44,298	10,976	28,043	28,464	111,782

Note
1 The pipeline corridor is 27 miles long and 80 feet wide.

Livestock operations consist primarily of cattle raising. Cattle are grazed on private and BLM lands in the western Carbon and Emery Counties during the winter and spring months. Livestock are usually moved to higher elevations in the summer and early fall months. Grazing on BLM allotments in the North and South Areas is described in the Livestock Management Section 3.11 of this chapter.

In western Carbon and Emery Counties, croplands are located on flat-lying lands with irrigable soils (Office of Surface Mining 1985). These areas are irrigated by flood and by water diverted by a ditch from a stream. Croplands produce hay crops, silage, grains, vegetables and melons. Irrigated croplands occur along the Price River between the towns of Wellington and Helper. There are no irrigable agricultural lands in the North Area.

Huntington, Cottonwood and Ferron Creeks drain the central part of the Wasatch Plateau, and flow through the South Area to empty into the San Rafael River to the east. Irrigated croplands are located along the lower reaches of the creeks at the east side of the South Area. Canals lead to irrigated land north and south of each stream in the area.

There are three soil types in the North Area that meet the soil requirements for prime farmland when irrigated (Soil Conservation Service 1988). The soil types are Green River-Juva Variant complex, Haverdad loam, moist; and Ravola loam. The soils are described in the Soils section of Chapter 3. These soils are currently in use as grazing land. None of the land in the North Area is irrigated.

There are ten soil types in the South Area that meet the soil requirements for prime farmland when irrigated. The soil types are Billings silty clay loam, Green River-Juva Varient Complex, Haverdad loam, Hernandez, Hunting loam, Minchey loam, Penoyer Variant loam, and Ravola loam. These soils are described in **Section 3.4**. These soil types comprise 2,475 acres and occur sporadically along Huntington and Cottonwood Creeks, and in areas west of Orangeville and north and east of Clawson.

3.10.2.2 Oil and Gas Developments

Public lands administered by the BLM in the Price Field Office are available for oil and gas leasing, exploration and development. As of November 10, 1997, the number of applications for permit to drill in Carbon and Emery counties are 36 and 24 permits, respectively. Drilling activities in Carbon and Emery counties are summarized in **Table 3–23**.

The majority of permits (31) issued in Carbon County in 1997 as of November were issued to Price CBM and Anadarko in the Price CBM Project Area and the North Area. As of December 1997, there were 15 active wells in the North Area. Seven wells are located on BLM lands, and eight wells are on state-owned land. The wells were completed in the Ferron Sandstone in the years 1994 through 1998.

In Emery County, 21 of the 24 issued permits were to Texaco in the South Area. Coal bed methane well development in the Price CBM Project Area adjacent to the North and South Areas is described in the 1997 FEIS for the Price Coalbed Methane Project. Existing development in the South Area consists of 53 active wells as of December 31, 1997.

3.10.2.3 Mining

The location of active mining is discussed in **Section 3.1.5.4**.

Table 3–23
Drilling Permits in Carbon and Emery Counties

Carbon County:	1997	1996	1995	1994
Application for Permit to Drill	36	38	21	50
Well Completions	15 PGW 1 SERV	5 PGW 4 SGW 2 SERV 1 TA	18 PGW 1 PA	na
Emery County:				
Application for Permit to Drill	24	23	20	18
Well Completions	12 PGW 1 PA	6 PGW 6 SGW 1 SERV 1 PA	4 SGW 2 PA	na

Note:
PGW = Producing Gas Well, SGW = Shut-in Gas Well, TA = Temporarily Abandoned, PA = Plugged and Abandoned, SERV = Service Well (water injection, gas injection, water disposal).
Source: UDOGM 1997

3.10.2.4 Residential

Rural residences within the North and South Areas are located near communities. Residences in the South Area are within the city limits of Clawson, Orangeville and Huntington. Other residences are rural residences located along roads in the South Area. The number of residences within the North and South Areas are shown in **Table 3–24**.

Table 3–24
Residences within the North and South Areas, and the Pipeline Corridor

Study Area	Houses Within City Limits	Rural Houses	Total
North Area	53	0	53
South Area	71	38	109

There are 53 residences in Kenilworth that are located within the North Area. All other residences in Kenilworth are within 0.14 miles of the North Area. There are no residences in Helper and Spring Glen within the North Area, but there are numerous homes in these communities that are within 0.5 miles of the North Area's boundary.

All residences within the pipeline corridor are located along the portion of the corridor following the existing Questar Pipeline. The section of the pipeline that will consist of new right-of-way is located on public lands. There are no residences along this portion of the corridor.

3.10.2.5 Utilities and Rights-of-Way

3.10.2.5.1 North Area

A powerline crosses through the North Area southeast from Kenilworth. A powerline is located adjacent to the southwest boundary of the North Area. Two powerlines cross through the North Area. A pipeline corridor extending from Price to Nine Mile Canyon crosses through the south end of the North Area.

3.10.2.5.2 South Area

Two power plants operated by Utah Power and Light Company are located in Castle Valley. The Hunter plant is located adjacent to the east boundary of the South Area about two miles south of Castle Dale. The Huntington plant is within the South Area in Huntington Canyon, accessed by State Route 31. Research farms at the Hunter and Huntington power plants use spent cooling water to produce grain crops and cattle.

A power line extends southeast across public and private lands in the South Area from a substation adjacent to the power plant. A power line extends from the same substation to tie in with power lines at Helper.

Right-of-way corridors that cross through BLM lands within the North and South areas include oil and gas facilities and water lines, are summarized in **Table 3–25**.

3.10.2.5.3 Pipeline Corridor

The proposed pipeline corridor would be located adjacent to the existing Questar Pipeline corridor. The Questar Pipeline is located in a right-of-way that extends from Price to Ferron, near the State Route 10 highway corridor. The existing pipeline is a 6-inch line that includes tap lines that serve each community along the pipeline corridor.

3.10.3 Land Use Planning and Management

BLM lands in the entire Project Area are now managed by the Price Field Office. Before the BLM restructured, the North Area was managed by the Price River Resource Area and the South Area was managed by the San Rafael Resource Area. Therefore, management plans for each area are still in effect and both the Price River Management Framework Plan and the San Rafael Resource Management Plan are referenced. In addition. the National Forest lands in the South Area are managed under the Manti-La Sal National Forest Plan. Private lands in the Project Area are covered by county master plans and zoning plans for Carbon and Emery Counties as well as the local municipalities.

3.10.3.1 BLM Land Management Direction

As stated above, the management direction for BLM lands in the Project Area varies between the North and South Areas. Both the RMP covering the South Area and the MFP covering the North Area provide BLM's direction for managing the resources in their respective areas.

The management objective for oil and gas development in the Price Field Office area is to lease public lands for oil and gas, to allow geophysical activity to occur only so long as management plans are met, and to administer operational aspects of federal oil and gas leases where BLM does not manage the surface. BLM-

Table 3–25
Rights-of-Way in the Project Area

	Serial Number	Type	Legal Locations	Proprietor	Comments
North Area:	74314	oil & gas pipeline	T13S R10E sec. 23	Anadarko Petro. Corp.	Expires 10/3/2006
	71854	oil & gas facility site	T13S R10E, sec. 22, 23, 27, 34	Anadarko Petro. Corp.	Expires 9/19/2004; 13.78 acres
	067467	oil & gas pipeline	T14S R10E sec. 11, 12 T14S R11E sec. 6, 7	Questar Pipeline Co.	Expires 1/1/1999
South Area:	0146663	oil & gas pipeline	T19S R8E, sec. 7, 18 T17S R9E, sec. 4	Questar Pipeline Co.	Asgn approved for Mtn Fuel Supply 7/23/1984
	52401	Trans-solid	17S R7E, sec. 2	Pacificorp DBA UPL	Expires 5/2/2013; 0.738 acres
	57139	oil & gas pipeline	T19S R7E, sec. 1, 3, 11, 12, 13 T19S R8E, sec. 18	Chandler & Assoc. Inc.	Expires 10/15/2001
	71862	water pipeline	T18S R7E, sec. 12	Jim Peacock	Pending 12/5/1994; 1.0 acre; unauthorized use
	74338	water pipeline	T18S R7E, sec. 7	Castle Valley Special Service District	Expires 12/29/2027 1.0 acre

Source: BLM 1997c

administered public lands in the South Area are in Oil and Gas Leasing Category 2 – Open With Special Conditions (BLM 1991c). Category 2 prescriptions consists of seasonal restrictions that apply to desert bighorn sheep crucial habitat, antelope crucial habitat, and mule deer and elk crucial winter ranges. BLM management direction for the various other resources is discussed in the appropriate sections of this chapter.

3.10.3.2 Carbon County Land Use Planning

County land use controls in Carbon County include the Carbon County Master Plan (Carbon County 1997), adopted in October 1997 and a Zoning Ordinance (Carbon County 1995). The Master Plan focuses on six major issues identified by County residents, including 1) economic development, 2) human services and education, 3) infrastructure and resources, 4) private land use, 5) public lands and resources, and 6) recreation and tourism. The issues are developed through policy statements, objectives, strategies and action steps designed to accomplish County goals and objectives.

The Carbon County Zoning Ordinance is currently being updated by the Carbon County Planning and Zoning Department. The zoning ordinance and decisions of the Planning Commission will be reviewed for consistency with the County Plan. The current zoning ordinance will be in effect for land planning purposes until the new ordinance is developed and approved.

Under the current ordinance, all of the North Area is within the M&G–1 – Mining and Grazing zone with the exception of an R–1–8K – Residential zone that contains the unincorporated community of Kenilworth (**Plate 3–8**). The Glen Canal runs along part of the west side of the North Area, between Helper and Spring Glen. The lands on the west side of Glen Canal adjacent to the North Area are within Rural Residential zoning districts.

The M&G–1 zone consists of low rangeland areas of county that are used for the grazing of livestock, mining and mineral exploration. Production wells are Permitted Non-Conditional Use of the zone. The R–1–8K zone district in the North Area includes existing residential and associated infrastructure development in Kenilworth. Production wells are a Permitted Conditional Use of the zone.

3.10.3.3 Emery County Land Use Planning

The Zoning Resolution for Emery County adopted in 1970 includes amendments current through November of 1995 (Emery County 1995). The Zoning Resolution has established zoning districts to implement land-use controls that limit the uses to which land in an area may be put. There are the following four zoning districts within the South Area (shown on **Plate 3–8**): A–1 (Agricultural), M&G–1 (Mining and Grazing), I–1 (Industrial), and CE–2 (Critical Environmental).

Most of the South Area is in M&G–1 – Mining and Grazing. The zone consists of dry mountain and desert areas that generally contain economically significant mineral deposits. The area has been historically used for the grazing of livestock on the open range and as the location of numerous mining and mineral exploration sites. Production wells are a Permitted Conditional Use of the zoning district that is subject to the prior approval of the County Commission.

Agricultural lands along creeks that run through the South Area are in the A–1 – Agricultural zone. The zone was established as a district in which the primary use of the land is for agricultural and livestock raising operations. Exploratory, oil and gas wells are a Permitted Administrative (Planning Commission) Conditional Use requiring a Small Site Plan Approval.

Approximately ½ section north of Castle Dale is zoned with I–1 Industrial. The I–1 zone is characterized by a mixture of industrial, manufacturing and processing establishments. Production wells are a Permitted Conditional Use of the zoning district that is subject to the prior approval of the County Commission.

A small area of land in Huntington Canyon in the northwest part of the South Area is in the CE–1 Critical Environmental zoning district. The CE–1 district includes canyon, mountain, riparian and other lands of environmental concern. Land within the zone has historically functioned as a primary watershed for much of the irrigation and culinary water supply for the area. Uses that tend to degrade the quality of the environment are not permitted. Exploration and production wells are not covered under the Permitted Non-Conditional Uses or Permitted Conditional Uses in this zone.

3.10.3.4 Utah State Land Management

Approximately 2,935 acres in the North Area and 9,035 acres in the South Area are owned by the state of Utah. Most of the state lands are administered by SITLA (SITLA 1996). The SITLA was created to manage real estate trust funds granted to the state by the United States at statehood. The trust lands are managed for the financial benefit of beneficiaries that include common schools (grades K through 12), reservoirs, Utah State University and other institutional beneficiaries. Nearly 96 percent of state trust lands support common schools. Sections 2, 16, 32 and 36 in every township were granted for the support of common schools. In Carbon County, approximately 94,637 acres of land are under trust land surface ownership. In Emery County, 299,015 acres of land are state trust lands.

Approximately 270 acres are Utah State Park/Recreation Area lands within the Huntington Lake State Park. Recreation opportunities in the park are described in **Section 3.12**.

Utah State Wildlife Reserve (SWR) lands are located along State Route 31 west of Huntington. There are two parcels of SWR lands. An 80-acre parcel is located on the north side of the town of Huntington. Another 80-acre parcel is accessed from State Route 31 about 1.5 miles from Huntington. There is currently no formal mechanism used to resolve land use conflicts (Utah State Legislature 1997). Land use planning for wildlife lands has been identified as a potential issue for the 1998 Utah General Session. It is anticipated that there will be legislation that will create a land use planning process for SWR lands.

3.10.3.5 Manti-La Sal National Forest Management

Approximately 10,931 acres of land in the South Area is within the Manti-La Sal National Forest. There are four Forest management units on National Forest System lands within the South Area; General Big Game Winter Range (GWR), Leasable Mineral Development (MMA), Key Big Game Winter Range (KWR), and RNG, managed for timber and forage (Forest Service 1986). Most of the South Area National Forest lands are in GWR and RNG units. Lands along creeks, including Whetstone Creek, Grimes Wash, Killpack Canyon and Rock Canyon are in the MMA unit.

Forest-wide stipulations do not allow surface occupancy on slopes greater than 35 percent. With the exception of lands along some creeks, most of the National Forest lands in the South Area are on slopes greater than 35 percent. These lands are within the Huntington Canyon and Cottonwood oil and gas analysis areas. There are two oil and gas lease types with stipulations for surface occupancy as follows:

- TL1/TH1 — Lease with Timing Limitation Stipulation No. 1 and Threshold Stipulation No. 2. Surface occupancy for construction of facilities and drilling is not allowed from December 1 to April 15. Disturbance of the ground surface and disturbance (area avoided) of wintering big-game would be limited to 10 percent of the GWR Management Unit.

- STD — Lease with standard terms and forestwide stipulations only.

3.10.4 Transportation

The transportation network that serves the proposed project Area consists of federal and state highways, local roads, and BLM roads. The network would be used by workers and vehicles hauling equipment and supplies to the Project Area.

3.10.4.1 Public Road Network

State Route 10 is the primary north-south transportation route through Carbon and Emery Counties and links the communities of Huntington, Castle Dale, Clawson and Ferron between Price and Interstate–70 to the south. U.S. Highway 6 connects Price with Salt Lake City 120 miles to the northwest. State Routes 29 and 31 connect State Route 10 with the Manti-La Sal National Forest to the west.

The primary access into the North Area is from county and BLM roads, and from State Route 157, which connects the community of Kenilworth with State Route 6. There are approximately 303 miles of roads in the North and South Areas. Local roads provide access to roads and trails on BLM lands from the neighboring communities of Price, Carbonville, Spring Glen, Helper, and Kenilworth. Access to the North Area is also available by four-wheel drive and graded roads that connect with the Nine Mile Canyon National Back Country Byway, located about five miles to the east.

State Route 10 provides access to the South Area by way of county roads, and state routes. The primary routes that connect with State Route 10 are State Route 31, State Route 29, and State Route 57. Most of State Routes 29, 31 and 57 are within the South Area. State Route 29 crosses through the South Area between the Manti-La Sal N.F. boundary and the north limit of Orangeville. State Route 31 is a scenic byway that crosses through Huntington Canyon in the South Area between the National Forest's boundary and the northwest limit of Huntington at State Route 10. State Route 57 connects State Route 10 with the Cottonwood/Wilberg Mine to the north of the South Area's boundary.

The pipeline corridor in Emery County parallels and overlaps an Questar Pipeline's existing right-of-way. This part of the corridor is accessed from State Route 10 and from other state and local routes that connect with State Route 10. The remainder of the pipeline corridor is in new right-of-way on public lands. The new pipeline right-of-way is located partially along existing county roads and is accessible from several county roads.

Annual Average Daily Traffic (AADT) counts for U.S. Highway 6, State Route 10, State Route 29 and State Route 31 were obtained from the Utah Department of Transportation (UDOT). AADTs consist of the annual average of traffic weekly traffic counts calculated from Sunday through Saturday. The AADTs were counted for the entire length of each State Route **Table 3–26** show the counts for each segment of U.S. Highway 6 and State Route 10 that are accessed from the North and South areas in Carbon and Emery counties.

Table 3–26 shows each segment of State Route 6 between the northern incorporated limits of Helper and the Carbon-Emery County line, a distance of nearly 46 miles. Traffic levels are highest in the vicinity of Price, particularly on sections at the junctions of State Routes 244, 10 and 55. The levels are highest at the west incorporated limits of Wellington, located north of the North Area. Wellington is at the junction of several county roads.

State Route 10 section length AADTs are shown between the junction of Main Street and S.R 55 100 North Street in Price and the south incorporated limits of Ferron, a distance of nearly 41 miles. The AADTs show decreasing traffic levels heading south on State Route 10.

3.10.4.2 BLM Roads

Numerous improved and unimproved (four-wheel drive) roads are located in the North and South areas, as shown on **Plate 2–1** in Chapter 2. The transportation system on BLM lands within the management area consists of roads maintained under four road classes, consisting of temporary, resource, local and collector type roads. BLM road classes are described in Chapter 2. Prior to gas field development, roads on BLM lands were primarily maintenance Level 2 roads. Existing gas field development has resulted in the addition of new roads and the upgrading of existing roads. Currently, most roads are maintained as Level 3 roads. A description of the use of gas development roads on BLM lands follows:

Table 3–26
Annual Average Daily Traffic Counts in Carbon and Emery Counties

County	Route Name	Description	1995	1996
Carbon	SR 157	south incorporated limits of Helper	2,150	2,510
	SR 157	junction SR 139 – Kenilworth	555	555
	US Hwy 6	north incorporated limits of Helper	6,385	6,095
	US Hwy 6	south incorporated limits of Helper	13,590	12,975
	US Hwy 6	west incorporated limits of Price	10,600	10,075
	US Hwy 6	junction SR 55 west of Price	9,895	9,500
	US Hwy 6	junction SR 10	11,185	10,965
	US Hwy 6	junction SR 55 and south incorporated limits of Price	14,900	14,610
	US Hwy 6	west incorporated limits of Wellington	15,725	15,415
	US Hwy 6	Carbon – Emery county line	3,390	3,410
	SR 10	junction SR 6 Price bypass	8,895	8,730
	SR 10	south urbanized boundaries of Price	7,035	6,780
Emery	SR 10	Emery – Carbon county line	5,130	5,055
	SR 10	north incorporated limits of Huntington	5,150	5,080
	SR 10	junction SR 31	6,810	6,730
	SR 10	junction SR 29	5,835	5,765
	SR 10	north incorporated limits of Castle Dale	3,235	3,250
	SR 10	junction SR 57	4,050	4,000
	SR 10	north incorporated limits of Clawson	3,310	3,835
	SR 10	north incorporated limits of Ferron	3,310	3,835
	SR 29	Manti-La Sal N.F. boundary	995	885
	SR 29	junction SR 57	2,380	2,245
	SR 29	north incorporated limits Orangeville	2,750	2,590
	SR 29	east incorporated limits Castle Dale – junction SR 10	3,940	3,720
	SR 31	Manti-La Sal National Forest boundary	1,400	1,320
	SR 31	road to Bear Creek Canyon	1,825	1,720
	SR 31	road to Deer Creek Canyon Power Station	3,655	3,445
	SR 31	northwest incorporated limits of Huntington	4,375	4,125
	SR 57	junction SR 10	985	950
	SR 57	local road to Orangeville	900	865
	SR 57	SR 29 – Cottonwood/Wilberg Mine	900	865

Source: UDOT 1996, 1997

- Temporary roads are low volume, single-lane roads located, designed, and constructed for temporary use. They are constructed to be made impassable to vehicle travel and returned to a near natural condition upon completion.

- Resource roads are low volume, single-lane roads that may be reclaimed after a particular use terminates. These roads connect terminal facilities, such as a well site to collector, local, arterial, or other higher class roads. They serve low average daily traffic. They may be developed for either long- or short-term use, and operated either closed or open to public use.

- Local roads are normally graded, drained, and surfaced and are capable of carrying highway loads. They collect traffic from resource or local roads or terminal facilities, and are connected to arterial roads or public highways.

- Collector roads serve large land areas and are the major access route into development areas with high average daily traffic rates. They usually connect with public highways or other arterials to form an integrated network of primary travel routes and are operated for long-term land and resource management purposes and constant service.

3.10.4.3 County Transportation Planning

The Emery County General Plan (Emery County 1995) anticipates that coal-bed methane extraction will require development roads that impact the unimproved native portions of the County road system. The Plan notes that the extracted product is transported by pipeline, causing the access roads to be incidental to the industry, and of little use to the local economy, and therefore not a worthwhile County investment. An objective of the Plan is to encourage roads to be constructed or improved by development interests and assure they meet acceptable standards for safety, structure and widths as determined by the County Engineer or Road Department Supervisor in compliance with the existing Road Encroachment Ordinance 8–7–85A.

The primary transportation issues identified in the Carbon County Comprehensive Plan is to improve safety on U.S. Highway 6 and State Route 10 and to increase County participation in transportation and highway planning decisions. Safety on State Route 10 has become a serious concern in recent years. The highway is a high-speed road, and can be dangerous to enter or exit from the narrow driveways and roads that connect to it. The County intends to explore possible zoning changes that could require safer entry points on the highway, and to examine issues that have been identified in the UDOT's feasibility study for improvements in the area.

3.10.4.4 Other Transportation

Rail service in Carbon County is provided by the Union Pacific Railroad. The railroad tracks connect Helper, Price and Wellington with the Provo area to the northwest, and continue east from Wellington. Utah Railway operates a spur line between Helper and Hiawatha in Emery County that connects coal mines in the area to the Union Pacific line.

The Carbon County Airport is located three miles east of Price partially within the North Area. The airport has three runways and two helipads (Air Nav 1997). Part of Runway 18/36 is within the North Area. The runway is 8,300 feet long, 100 feet wide, and oriented in a southwest-northeast direction. A TVOR (Very High Frequency Omnirange) site is on the field at the airport. A TVOR tower site radiates azimuth information for nonprecision instrument approach procedures.

3.11 LIVESTOCK MANAGEMENT

3.11.1 Regional Overview

Livestock grazing is a primary use for both public and private lands in the region. While livestock grazing has had a historic presence in the area, its economic success has been marginal due to the low carrying capacity of the land. This restrictive carrying capacity is due to the arid vegetation types within the area ranging from pinyon-juniper and sagebrush grassland to salt desert. Grazing patterns are typically managed to maximize what production does exist. The higher altitudes are utilized in the growing season, and the valley floor is grazed from spring to early summer, and during the fall and winter.

3.11.2 Allotments in Project Area

There are 22 BLM grazing allotments either completely or partially within the Project Area. **Plate 3–9** shows the extent of each allotment and **Table 3–27** summarizes allotment grazing information. As noted in this table, all of the livestock are domesticated varieties, and cattle and sheep are the primary livestock type grazed. **Table 3–27** also contains the management category of each allotment. The categories were defined by the BLM and established to provide priorities for distributing available funds and personnel in a manner that would achieve a cost-effective improvement in both rangeland condition and production. They are described in **Table 3–28**.

3.11.3 Carrying Capacity, Livestock Management and Facilities

The carrying capacity of an allotment is defined in terms of Animal Unit Months. This information, along with the livestock type, period of use, BLM management category, and ecological range condition, is provided in **Table 3–27** for each grazing allotment. Any reduction in the amount or quality of these factors can have a negative effect on the carrying capacity of the allotment.

Livestock operators use the existing road network to move cattle to the allotments and to access the allotment to check on their livestock, fix fences, inspect water tanks, distribute salt and other maintenance activities. Any restrictions in the ability of livestock operations to access the allotments would impact their ability to perform the necessary livestock management activities.

The grazing allotments contain various range improvements which are used to control animal movement and to provide water for livestock. Improvements include fences, cattle guards, corrals, developed springs and wells, detentions dams, reservoirs, and water pipelines. In some areas, pinyon-juniper has been chained to encourage herbaceous forage. Disruption of these range improvements could impact the control of livestock on the established grazing allotments.

3.12 RECREATION

3.12.1 Introduction

This section identifies existing recreation uses of lands in the North and South Areas, and along the Pipeline Corridor. A field reconnaissance of the Project Area was conducted with the BLM recreation specialist in

Table 3–27
Summary of BLM Grazing Allotments

Allotment Name	Acres: Public	Acres: State/Pvt.	AUMs on Public Land	Acres/AUM[1] PublicLand	Livestock Type	Period of Use	Mgmt. Category	Ecological Range Condition: PNC[1]	Late Seral	Mid Seral	Early Seral	Unsuitable
SOUTH AREA												
Clawson Dairy	1,830	85	65	28	C	5/1 – 5/31	M	0	0	77	0	0
Cowley	710	0	101	7	C	5/1 – 5/31	C	0	0	100	0	0
Cox (Don)	500	160	71	7	C	10/1 –11/30	C	78	0	18	4	0
Cox (John)	1,350	0	146	9	C	10/16–1/31	M	0	0	99	1	0
Deep Wash	2,540	1,190	7	148	C	4/1 – 6/10 11/1 – 11/30	M	0	0	100	0	0
East Grimes	3,761	960	146 129	14	C C	4/1 – 4/30 5/1 – 6/15	M	0	0	15	85	0
Humphrey	80	0	20	4	C	6/1 – 6/20	C	0	0	100	0	0
Jensen	260	0	10	26	C	1/1–3/31	C	0	0	100	0	0
N. Huntington	1,335	17,185	46	12	C	11/1 –12/15	I	36	0	40	10	14
Northwest Ferron	1,980	840	110 8	17	C C	5/1 – 5/31 4/1 – 6/15	M	0	27	73	0	0
North Wolf Hollow	90	30	8	11	C	5/1 – 10/31	C	0	0	100	0	0
Peacock	3,140	0	56	56	C	4/1 – 6/10	I	29	0	30	41	0
Reid	200	0	12	17	C	10/16–12/31	C	0	0	100	0	0
Rock Canyon	2,770	610	156 80	12	S C	4/16–5/31 4/16 – 5/31	I	0	0	100	0	0
South Wolf Hollow	740	160	30	25	S	4/21–6/20	C	78	0	100	0	0
West Grimes	4,440	530	295	15	C	4/1 – 6/10	M	0	30	54	16	0
West Huntington	11,960	5,540	138	87	C C	5/1 – 6/26 11/1– 12/15	I	34	1	28	37	0
West Orangeville	4,700	510	208 20	21	C	4/20 –6/10 10/16–12/31	C	68	0	26	6	0
Wilberg	2,562	2,875	46 62	16	C C	11/1–12/15 4/16–6/15	C	0	5	77	18	0

Table 3–27 (continued)
Summary of BLM Grazing Allotments

Allotment Name	Acres: Public	Acres: State/Pvt.	AUMs on Public Land	Acres/AUM[1] PublicLand	Livestock Type	Period of Use	Mgmt. Category	Ecological Range Condition: PNC[1]	Late Seral	Mid Seral	Early Seral	Unsuitable
NORTH AREA												
Coal Creek	15,351	1,965	851	18	C C	4/16–5/31 10/16–10/31	I	0	6,140	7,983	1,228	0
Hayes Wash	6,135	3,460	342	18	C	10/15–5/31	M	0	1,396	3,405	1,334	0
Wood Hill	2,769	1,680	205	16	C	3/1–5/31	M	0	0	1,523	1,246	0
FOREST SERVICE ALLOTMENTS — SOUTH AREA ONLY												
East Mountain	11,221	8,107	1,230	9	C	6/21 – 9/10	I[2]		38	48	14	71
Horn Mountain	70,309	1,607	4,371	16	C	6/9 – 9/30	I[2]		17	69	14	59
Gentry Mountain	37,754	5,062	6,083	6	C	6/27 – 9/30	I[2]		17	30	53	79
Trail Mountain	20,139	1,188	3,646	6	C	6/21 – 9/20	I[2]		14	74	12	65

NoteS:
1. AUM = Animal Unit Month, PNC = Potential Natural Community
2. High priority allotment with big-game winter range an/or watershed improvements.

Table 3–28
BLM Range Management Category Types

Management Category	Range Condition	Production Levels	Resource Use	Livestock Management	Potential for Economic Return
Maintain	satisfactory	near potential	no serious conflicts	appears to be satisfactory	
Improve	not satisfactory	below potential	serious conflicts	appears to be unsatisfactory	high
Custodial	not a factor	near potential	no serious conflicts	appears to be satisfactory	low

October 1997. Existing recreation and land uses were identified. Public access to recreation opportunities on public lands and lands adjacent to the Project Area was discussed.

Carbon and Emery counties offer varied scenic terrain ranging from desert to mountains, which provide a setting for many forms of outdoor recreation. Major attractions include the San Rafael Swell, the Book Cliffs-Westwater Area, Ninemile Canyon, and the Manti-La Sal National Forest (BLM 1994a). Recreation areas within or adjacent to the North and South areas are Huntington Lake State Park and Millsite State Park.

Approximately 61 percent of Carbon County lands and 92 percent of Emery County are public land. Public lands provide open space for a variety of dispersed outdoor recreation opportunities, as well as developed facilities to help meet the demand for site-oriented recreation. Recreation opportunities offered by the private sector consist of community facilities in urban areas and the infrastructure of tourist services and facilities.

The primary users of recreation resources within the Project Area are local residents. The western half of Emery and Carbon Counties have not been a significant destination for recreation and tourism visitations, except the San Rafael Swell and the Green River. However, there is traffic through both counties from the Wasatch Front to other outdoor recreation areas that represent a potential market in part because of the opportunities offered by public lands. Carbon County has indicated that there is an increasing interest in local recreation opportunities in recent years.

3.12.2 Recreation Use

Public lands in Carbon and Emery Counties provide diverse recreational opportunities, including camping, backpacking, hiking, mountain biking, fishing, picnicking, hunting, whitewater rafting, horseback riding, all-terrain vehicle (ATV) and motorcycle riding, and winter sports.

3.12.2.1 Trails

The area around Price has an informal network of trails, routes and open space used for various motorized and non-motorized recreational pursuits. These include hiking, walking, running, horse riding, mountain biking, cross-country skiing, tubing, sledding, snowmobiling, dog walking, ATV use, dirt biking, 4-wheeling, birding and wildlife watching. The North Area contains about 80 miles of roads and trails that can be used as recreation trails. Other recreation activities include archery, shooting and hunting. Price's open space attracts many of the newer residents to this area and is a valued asset to long time residents. However, no statistics on Recreation Visitor Days have been compiled for public lands in the Project Area. The BLM outdoor recreation planner estimates the North Area received 10,000 user days per year before the development of gas wells and road improvements.

There are numerous four-wheel drive roads and informal trails on public lands in the South Area, and along the pipeline corridor on lands west of Price. These lands that are used for a variety of trail related activities. Many roads and trails in the North and South areas provide easy access to public lands from local communities, and are popular with local recreationists.

Carbon County has prepared the 1995 Carbon County Trails Plan (Carbon County 1995) as an appendix to the Carbon County Comprehensive Plan. The plan identifies existing trail use and potential trail projects in Carbon County. The overall goal of the Trails Plan is to establish trail corridors that will enhance community development and the quality of life for local residents, and to possibly generate opportunities for economic development.

The Plan identified several different trail user groups in the Carbon County area. The most popular outdoor recreation trail related activities identified by the Plan are ATV riding, motorcycling, horseback riding, cross country skiing, 4WD vehicles, snowmobiling, bicycling, hiking and dog walking. Additionally, several organized groups, including the Rocky Mountain Elk and Deer Foundation, Utah Sportsman Association, and other recreational clubs, regularly use the public lands.

There are no designated trail systems within the North and South areas and the Pipeline Corridor. The existing state of trail use is mostly informal, unmarked routes. With the exception of organized and group events, users tend to be local residents who have developed knowledge of suitable trails by use type over time, through self-exploration, and word of mouth (Keleher 1995). Under the direction of the Carbon County Trails Plan, Carbon County is developing a system of trails in Carbon County and within the North Area. Neither a formal designation of trails nor land owner's permission to use these trails has been finalized. The proposed trails plan is shown on **Plate 3–10**.

The nearest trail system is the Helper Parkway, which runs along the banks of Price River in Helper. Long-term plans for the parkway are to extend it through Price Canyon to Wellington, located south of the North Area. Other designated trail systems in the area are the Castle Valley Ridge Trail System, located on National Forest lands west of the South Area and the Ninemile Canyon Back Country Byway.

A mountain biking guide was developed by the Castle Country Travel Council to describe biking and hiking routes in the Castle County region, including trails on the Wasatch Plateau, San Rafael Swell, the Green River area, and Carbon and Emery counties. There is one route described in the guide that is within the North Area. The 14-mile Kenilworth Loop (**Plate 3–10**) begins in Price, and heads north through the North Area to Kenilworth. The route continues east along the base of the Bookcliffs to connect with a road that loops to the south back to Price, paralleling the northward road. Several informal trails and 4-wheel drive roads connect with the route, providing recreation access into most of the North Area.

In addition to the Kenilworth Loop, there is an informal network of trails using existing roads, also shown on **Plate 3–10**, in the North Area used for various motorized and non-motorized recreational activities. These include trail-related activities such as hiking, running, horseback riding, mountain biking, cross-country skiing, tubing, sledding, snowmobiling, dog walking, strolling, ATV use, dirt biking, birding and wildlife watching. Other recreational activities include archery, shooting and hunting. These trails are planned to be signed at some time in the future to accommodate increasing levels of use. The existing trail network has been recently altered by natural gas development. The existing roads and trails have been improved to accommodate access to wells. The improvements have altered the characteristics of trails and 4-wheel drive roads (width, surface characteristics, roughness, winding curves) that results in a different experience for some recreationists depending upon their point of view.

3.12.2.2 Hunting and Fishing

Hunting is a major recreation use of public lands in the North and South Areas. Various big game and upland game bird species are hunted in the region. Big game species include deer, elk, and pronghorn. Big game populations are managed by the UDWR in herd management units. The South Area is within two deer management units and the North Area is within one big game management unit. **Table 3–29** summarizes the number of participating hunters and total hunter days for the big game management units that include the North and South areas.

Fishing is a popular year-round activity with residents of Carbon and Emery counties at Huntington Lake and Huntington Creek. Camping and picnicking along the creek within the South Area is currently informal and unmanaged and has resulted in some degradation of the riparian zone. It is likely that these types of uses will be regulated in the future.

Table 3–29
Big Game Hunting in North and South Study Areas

	1991	1992	1993	1994	1995	1996
NORTH AREA						
Deer Herd Unit 32 – Range Creek						
Hunters Afield	2,891	1,868	1,019	749	1,103	934
Total Harvest	918	704	282	316	383	355
Success Rate (%)	32	38	28	42	na	38
Elk Herd Unit 24 – Range Creek						
Hunters Afield	22	22	30	31	na	46
Total Harvest[1]	18	19	28	28	na	46
Success Rate (%)	80	86	93	90	na	100
Pronghorn Herd Unit 11 Icelander Wash						
Hunters Afield	37	37	27	33	31	39
Total Harvest[1]	33	34	25	30	26	37
Success Rate (%)	89	92	91	91	84	95
SOUTH AREA						
Deer Herd Unit 31 Southeast Manti						
Hunters Afield	5,864	4,222	1,609	1,258	1,454	1,402
Total Harvest	1,311	750	188	443	308	411
Success Rate (%)	22	18	12	12	35	29

Source: Utah Department of Natural Resources 1996

3.12.2.3 Other Recreation Use

Portions of Huntington and Cottonwood creeks within the South Area are used for whitewater kayaking. The stretch of Huntington Creek between the Huntington plant and the west boundary of the South Area is part of a 12.5-mile long reach that provides Class I to II whitewater rafting (American Whitewater Affiliation 1995b). An 8-mile long segment of Cottonwood Creek from Joe's Valley Reservoir (about 4 miles west of the South Area) to the east provides Class III to IV waters (American Whitewater Affiliation 1995a). Approximately 4 miles of this reach of Cottonwood Creek is in the South Area.

Cottonwood and Huntington Creeks flow through the South Area and merge to form the San Rafael River approximately 15 miles downstream of the South Area. The 65-mile long segment of San Rafael River between the junction of Ferron, Cottonwood and Huntington Creeks and the bridge at San Rafael Campground provides Class I to II whitewater kayaking and is very popular in season for floating trips (American Whitewater Affiliation 1995c).

There are several special events that are held on an annual basis within or near the North and South areas. The Castle Valley Pageant site is located seven miles west of Castle Dale within the South Area. The pageant is presented annually over a period of eight nights in late July and early August. More than 20,000 people attend the pageant to view a portrayal of the Mormon settlement of Castle Valley.

The Butch Cassidy Blow Out Mountain Bike Race occurred northeast of Price partially within the North Area. The race was part of the National Off-Road Bicycle Association sanctioned Cannondale Cup Mountain Bike Racing Series, which is an annual racing series based in Salt Lake City. The most recent Butch Cassidy Blowout occurred in June 1996.

The Team Wild Bunch Bike Race is held in the Wood Hill–North Price area in June. The race area is west and outside of the North Area.

According to the Bicycle Utah Vacation Guide (Bicycle Utah Inc. 1993), a popular tour for road cyclists is the scenic, 19-mile stretch of State Route 29 between Orangeville and Joe's Valley Reservoir.

State Route 10 is the primary north-south transportation route through Carbon and Emery counties. The highway connects with State Routes 29 and 31, which cross through the South Area and provide access to nearby recreation areas in the Manti-La Sal National Forest, including the Castle Ridge Trail System, Joes Valley Reservoir, and the Left Fork of Huntington Canyon Trail, which is a National Recreation Trail. Recreation areas to the east that are accessed from State Route 10 include Nine Mile Canyon to the northeast of the North Area, the San Rafael Swell (east of State Route 10), and the Book Cliffs (north of U.S. Highway 10).

3.12.3 Developed Recreation Areas and Recreation Use Sites

Carbon and Emery counties include several special recreation management areas on public lands. Part of the Huntington Lake State Park, located north of Huntington in Emery County, is within the South Area. Huntington Lake State Park consists of Huntington Lake and the immediate surroundings, which include facilities for recreational uses. There are 237 acres in the park that include 22 camping units, numerous picnic sites, boat launching, and a covered group-use pavilion.

Recreational activities available in the park include boating, water-skiing, sailing, windsurfing, swimming, camping, fishing, hiking, bird watching, picnicking, archaeological exploration, and photographic opportunities.

Millsite State Park is located adjacent to the south side of the South Area, near Ferron. Visits to Huntington and Millsite State Parks in the years between 1986 and 1996 are characterized by annual increases and decreases, as shown in **Table 3–30**. These fluctuations are not related to population changes in the counties (see **Section 3.15.1**). Declines in visits to the parks probably result from ongoing renovation and construction.

The Bear Canyon Campground, owned and operated by Emery County, is located in Huntington Canyon within the South Area. The campground includes camp sites, two pavilions, and picnic areas. The campground is popular with visitors to the annual Castle Valley Pageant in late July through early August (Cox 1998). The campground is used primarily on weekends, and weekday use is light. The heaviest use occurs on Memorial Day weekend and weekends in June and July. An estimated 2,000 visitors used the campground in 1996 (Funk 1997).

An informal sledding hill is located within the North Area on a north-facing slope overlooking Kenilworth. The sledding hill is use primarily by local residents of communities adjacent to the North Area. A roadside park, used primarily as a parking area, is accessed from State Route 10 approximately two miles northeast of Clawson.

3.12.4 Recreation Planning

Recreation on lands in Carbon and Emery Counties is administered by various government agencies through planning documents.

Table 3–30
Annual Visitation in State Parks In Carbon and Emery Counties, Utah; 1986–1996

Year	State Park Huntington Lake	Percent Change (Year to Year)	Millsite	Percent Change (Year to Year)
1986	78,489	-	53,043	-
1987	69,702	-11.2	34,674	-34.6
1988	63,505	-8.9	28,985	-16.4
1989	43,227	-31.9	32,713	12.9
1990	67,089	55.2	42,528	30.0
1991	78,936	17.7	43,659	2.7
1992	85,740	8.6	47,780	9.4
1993	70,621	-17.6	54,492	14.0
1994	75,543	6.7	45,751	-16.0
1995	58,264	-22.9	38,285	-16.3
1996	60,852	4.4	40,465	5.7

Source: UDNR 1997b

3.12.4.1 BLM

All lands in the North and South areas have been inventoried for Recreation Opportunity Spectrum (ROS) system to identify and evaluate recreation opportunities on public lands. The ROS system categorizes BLM lands in six classes, each of which is defined by its setting and by the possible recreation experiences and activities it offers.

The ROS inventory identified four ROS classes in the North and South areas as shown on **Plate 3–10** ranging from primitive to developed experience opportunities. Three ROS classes were identified in the North Area: Roaded Natural, Urban and Semiprimitive Motorized classes (BLM 1994b). Most of the North Area is Roaded Natural. North Area lands adjacent to the communities of Helper and Spring Glen are in the Urban class. A small area of lands in the northwest part of the North Area at the base of the Bookcliffs is in the Semiprimitive Motorized class. There are four ROS classes that have been mapped and inventoried in the South Area. These are urban, rural, roaded natural, and semi-primitive motorized. The management objectives for ROS classes in the North and South areas are defined below.

Urban — The Urban class is characterized by a highly modified environment, although the background has natural elements. Sights and sounds of man predominate, and large numbers of users can be expected.

Rural — The Rural class characterizes a substantially modified natural environment. Sights and sounds of people are evident, and the interaction between users is often moderate to high. The area is characterized by the sights and sounds of rural residential and agricultural land uses.

Roaded Natural — This class characterizes a predominantly natural environment with evidence of moderate permanent alternate resources and resource utilization. Evidence of the sights and sounds of people is moderate, but in harmony with the natural environment. Opportunities exist for both social interaction and moderate isolation from sights and sounds of man. These lands are crossed by numerous four-wheel drive roads and trails. The area has historically been used for grazing.

Semi-Primitive Motorized — This class is characterized by a predominantly unmodified natural environment. There are some opportunities for isolation from the sights and sounds of man, and a high degree of interaction with the natural environment. The interaction between users is low, but often there is evidence of other area users.

Off-highway vehicle (OHV) use designations have been applied to BLM lands in the Project Area. BLM lands in the North Area are open to OHV use. OHV use on BLM lands in the South Area is open but limited by the RMP to existing roads and trails (BLM 1991b). Specific road and trail designations have not been completed. Seasonal restrictions occur in deer and elk crucial winter ranges from December 1 to April 15. These seasonal restrictions do not apply to state, county, or BLM system roads or to private or state lands.

Existing roads and trails on State trust lands are open to OHV use unless signed closed or previously designated closed, and as long as the use is otherwise consistent with state law and not in conflict with current leases or permits.

3.12.4.2 Manti-La Sal National Forest

National Forest Sytem lands are inventoried and mapped by Recreation Opportunity Spectrum (ROS) class to identify the opportunities for recreation activities that occur on National Forest System lands. The ROS system is a continuum divided into six classes ranging from Primitive to Urban. All of the National Forest System lands in the South Area have been inventoried as the Semi-primitive Motorized class (Forest Service 1986).

The Semi-primitive Motorized class is characterized by a predominantly unmodified natural environment in a location that provides good to moderate isolation from sights and sounds of man except for facilities and travel routes sufficient to support motorized recreational travel opportunities that present at least moderate challenge, risk, and a high degree of skill testing.

3.12.4.3 County Recreation Planning

Emery County has prepared the Emery County General Plan (Emery County 1996), which has been updated through Autumn of 1996. The region is beginning to attract tourists, and a primary objective of the county for recreation and tourism is to develop a tourism industry that will bring maximum economic benefits with a minimum of negative effects on local resources and culture.

The county intends to conduct a tourism assessment to determine the costs and benefits of tourism in Emery County, and would identify the infrastructure developments that are needed to increase the benefits of tourism to the County.

The Carbon County Comprehensive Plan (Carbon County 1997) has identified recreation and tourism as one of the primary issues for the development of policies, objectives, and strategies. The Plan states that recreation and tourism is an essential element of Carbon County's continued economic vitality, and proposes to provide additional recreation opportunities for county residents while simultaneously improving community attractiveness in order to promote tourism.

3.12.4.4 State Recreation Planning

The 1992 Utah State Comprehensive Outdoor Recreation Plan (SCORP) (UDNR 1992) was developed by the Division of Parks and Recreation to help with state and local decision-making regarding outdoor recreation. The plan provides generalized guidelines for allocating federal Land and Conservation Fund monies to the state of Utah. The plan also provides information on the study of supply and demand; the identification of goals and objectives; estimated funds needed to achieve the objectives; analysis of critical issues; implementation of programs to solve identified issues; and development of special studies. Data on recreation uses and preferences of the public for recreation activities have been compiled for public lands in Utah.

The 1990 SCORP Household Recreation Survey includes preferences for recreation activities in the Southwestern Multiple County District (MCD), which includes Carbon and Emery counties. Results indicate that the five favorite activities are fishing, hunting and sightseeing by individuals and families, camping (developed and primitive), and picnicking.

3.13 VISUAL RESOURCES

3.13.1 Visual Resource Management

3.13.1.1 BLM

The BLM has inventoried visual resources for all BLM, state and private land in the Price Field Office area according to the Visual Resource Management (BLM 1986b) and established VRM classes. The VRM system is the basic tool used by the BLM to inventory and manage visual resources on public lands. The VRM classes are objectives that outline the amount of disturbance an area can tolerate before it no longer meets the objectives of the class. There are four VRM classes, each of which combines and evaluates visual quality, visual sensitivity of the area, and view distances. The inventory includes state and private lands as well as BLM lands, however the BLM manages visual resources only on BLM lands. Many private and public lands in the area have increased in sensitivity since the last inventory conducted in the 1970s as a result of increases in population and lifestyle shifts that emphasize outdoor recreation. Three VRM classes have been inventoried within the North and South Areas, as shown on **Plate 3–11**. The objectives of VRM classes in the North and South areas are:

- Class II — Class II provides for activities that would not be evident in the characteristic landscape. Contrasts are seen, but must not attract attention. Lands along the Huntington Canyon Scenic Byway are managed with Class II objectives. These lands are sensitive to public view.

- Class III — The objective is to provide for management activities that may contrast with the basic landscape elements, but remain subordinate to the existing landscape character. Activities may be visually evident, but should not be dominant.

- Class IV — The objective is to provide for management activities that may require major modifications to the existing landscape. The level of change to the landscape can be high and may be visually dominant.

3.13.1.2 Forest Service

The Forest Service has inventoried and mapped National Forest System lands that are adjacent to BLM lands with the BLM's VRM classes (Forest Service 1986). Most National Forest lands within the South Area are inventoried with BLM VRM Class III. National Forest lands in Rock Canyon, located northwest of the town of Clawson, are inventoried with BLM Class IV.

3.13.1.3 County Visual Resource Management

The Carbon County Comprehensive Plan (Carbon County 1997) has identified community attractiveness as a one of the primary strategies for developing recreation and tourism in the county. Plan goals related to enhancing the visual quality of Carbon County are:

1. Promote and improve the attractiveness of the entryways to Carbon County's communities. Develop a long-range plan for entryway beautification.

2. Help communities to work with UDOT in roadway beautification projects.

3. Develop an inventory of areas that need aesthetic improvements and rate them according to need.

4. Identify the owners of areas that need aesthetic improvements and form a committee to pursue beautification efforts in those areas.

The Emery County General Plan (Emery County 1996) identifies the existing rural character and scenic environment as an important aspect of the rural quality of life in the county. The County desires to preserve agricultural lands for both its economic and aesthetic benefits, and is interested in exploring open space/ agricultural land preservation techniques and alternatives.

3.13.2 General Visual Characteristics

The Project Area consists of public, state and private lands in Carbon and Emery counties in Utah. The Project Area includes the North Area, approximately 18,000 acres in Carbon County, and the South Area, approximately 93,000 acres in Emery County. The detailed study area for direct and indirect impacts consists of public lands in the North and South areas. The general study area for direct and indirect impacts consists of all private and state lands in the Project Area. The cumulative effects area includes that area potentially impacted by existing and proposed gas development in Carbon and Emery counties.

The Project Area lies in the Colorado Plateau physiographic province within the Castle Valley and is bordered by the Wasatch Plateau to the west and the San Rafael Swell to the east. The area is typified by rugged canyon and mesa terrain and an arid climate. Primary access to the Project area is State Route 10, the primary north-south transportation route through Carbon and Emery counties.

The eastern rim of the Wasatch Plateau is the dominant feature of the Project Area. The valley is rural and agricultural in character. Rangeland and cropland in the basin are interspersed with tree belts along perennial streams. Higher elevations in the Project Area, at the base of the Wasatch Plateau, consist of rolling terrain that is vegetated with pinyon, juniper, oak brush, sagebrush and grasses. The Wasatch Plateau on the west side of the Project Area provides a scenic backdrop to many views from within the Project Area. The diversity of topography, vegetation and geologic formations characteristic of the region provide a variety of scenic experiences to those who utilize the area.

3.13.2.1 North Area

The North Area is located at the base of the Book Cliffs east of U.S. Highway 6. Communities along the highway near the North Area include Price, Carbonville, Spring Glen, Helper, and Martin. Kenilworth is located on the north side of the North Area, and is partially within the North Area. The landscape is characterized by rolling terrain and flat-topped mesas vegetated with pinyon-juniper. As seen from a distance, the background views of the area presents a landscape of a uniform light brownish grey coloration interspersed with contrasting dark and light zones. When viewed in the middleground, the landscape exhibits a stippled appearance with light and dark contrasts between the vegetation, soil and rock. Closer foreground views reveal sparse shrubby vegetation interspersed with grassy openings and rock outcrops that create a mosaic of texture, forms and color. The general area is essentially natural and undeveloped in character. The landscape is composed primarily of scenery that is common for the region.

Existing development in the North Area consists of natural gas pumping units and associated well pads and access roads. The wells are intrusive (defined as readily visible) in foreground views from roads and trails. Roads and trails in the North Area are used for recreation by the local residents. In middleground and background views, the well pad is the most obvious feature of the development. Clearings are visible as a light brownish gray, geometric clearing with straight, linear edges that provide a contrast with the surrounding vegetation.

3.13.2.2 South Area

Existing visual modification to the South Area consists primarily of agricultural uses. Residential and commercial developments are located along State Route 10, which crosses north-south through the area. The communities of Huntington, Orangeville, and Ferron are accessed from State Route 10 on the east side of the South Area.

There is also modification to the landscape in the South Area from existing drilling activity. Other existing cultural modifications in the predominantly rural landscape in the North and South Area viewsheds include roads and highways, residences, two power plants, powerlines, and grazing improvements such as fences. Grazing is the primary land use north of Huntington. Croplands south of Huntington include haycrops and corn. The primary land uses of the region fall into the categories of ranching, farming, hunting, fishing, mountain biking, hiking and camping.

Most of the South Area is on flat to rolling terrain. Background views are dominated by the steep rim of the Wasatch Plateau. Horizontal layers of light tan to reddish brown shales and sandstones provide a dramatic backdrop to the rural landscape of the foreground and middleground views.

3.13.3 Key Observation Points (KOPs)

The primary views of the Project Area are from travel routes and recreation-use areas within the area. Travel routes include State Route 10 through the Project Area, county roads and BLM roads that access the area from the highway. Recreationists use public lands located throughout the area, including the Huntington Lake State Park and roads and trails throughout the North and South Areas. KOPs were selected to represent sensitive views of both areas. The location of each KOP is shown on **Plate 3–11** and are described below.

3.13.3.1 North Area

- KOP N1. The KOP is on a road at the south end of the town of Kenilworth, which is located at the mouth of a canyon that leads into the Book Cliffs. Views to the east are up a steep-sided valley, and includes a four-wheel drive road that provides access to roads and trails throughout the North Area. The view to the south is obstructed by a steep ridge. An existing well that is skylined near the top of the ridge is visible and other proposed wells would be seen in the foreground and middleground zones. Most of the North Area is obstructed from view by the topography.

- KOP N2. The viewpoint is on an improved, dirt-surfaced road along a drainage that accesses the North Area from Price. The road is used by mountain bicyclists and hikers, and it also provides access to the numerous four-wheel drive roads and trails that are also used for recreational activities. The views from this KOP are of the rugged terrain typical of the North Area. The views are of hilly to rugged terrain in the foreground and middleground zones. Background views are obscured by the terrain to the north, west and south of the KOP. An existing power line is visible in the background views to the east of the KOP.

- KOP N3. This viewpoint is located on a BLM road 2 miles southeast of Kenilworth. The views are of flat to rugged, sparsely vegetated terrain. An existing well and wellpad dominate the middleground views. The sharp line between the vegetation and the lighter gray-brown of the well pad is obvious.

3.13.3.2 South Area

- KOP S4. The Huntington Lake State Park is located less than one mile north of the town of Huntington adjacent to State Route 10. The park setting consists of a lake surrounded by landscaped lands that include facilities such as camping and picnic sites, a covered group-use pavilion, and a boat launch. Views of the Project Area on the south and west sides of the park consist of the lake and surrounding parklands in the foreground zones, the flat to rolling terrain of the Project Area in the middleground, and the steep rim of the dramatic Wasatch Plateau in the background.

- KOP S5. The KOP is on Huntington Canyon Scenic Byway (S.R. 31), which is part of a statewide system of scenic routes. The byway is a 48-mile scenic route between Huntington and Fairview, and provides access to scenic and recreational opportunities in the Manti-La Sal National Forest and to cultural and geologic points of interest. The KOP is located approximately 4.3 miles west of Huntington on the road, and provides a view to the north along Fish Creek, a tributary of Huntington Creek.

- KOP S6. This KOP is located on Huntington Canyon Scenic Byway (S.R. 31) approximately 0.3 miles east of the Bear Creek Campground, which approximately 10 miles west of Huntington. The view to the southeast is of dense stands of trees along Huntington Creek.

- KOP S7. The KOP is located on State Route 10 approximately 4.5 miles north of Castle Dale. The view is representative of views seen by travelers along the length of the highway through the South Area. The viewshed includes the flat to rolling terrain of lands in the foreground of the South Area to the west of the highway. Cultural features include a power line that consists of wood H-frame structures and conductors that are obvious in the foreground views.

- KOP S8. The Castle Valley Pageant site is located seven miles west of Castle Dale. The pageant is presented annually over a period of eight nights in late July and early August. Over 20,000 people attend the pageant to view a portrayal of the Mormon settlement of Castle Valley. The Pageant site is located on a ridge that provides panoramic views in all directions. The view to the southeast includes the ridgeline that provides a setting for the pageant. The west side of the ridge slopes down to rolling, hummocky terrain in a scenic protected bowl that is visible to the Pageant audience in the seating area. The Hunter Power Plant can also be seen to the southeast of the Pageant site. Views to the north and west are of steep terrain rising up to the Wasatch Plateau, and the dramatic cliffs of the Plateau in the middleground. The scenic setting is an essential element of the Pageant.

- KOP S9. This viewpoint is on State Route 29 on the north side of Orangeville. The views of the South Area are to the west along Cottonwood Creek, and to the north and south of agricultural lands.

- KOP S10. This viewpoint is at a radio tower on a Wasatch Plateau escarpment within the Manti-LaSal National Forest. The site provides a vista of the Castle Valley, including the South Area, and is representative of the views seen by users of the four-wheel drive roads and trails along the rim of the plateau.

3.14 NOISE

Noise is generally described as unwanted sound and discussions of environmental noise do not focus on pure tones. Commonly heard sounds have complex frequency and pressure characteristics. Accordingly, sound measurement equipment has been designed to account for the sensitivity of human hearing to different frequencies. Correction factors for adjusting actual sound pressure levels to correspond with human hearing have been determined experimentally. For measuring noise in ordinary environments, A-Weighted correction factors are employed. The filter de-emphasizes the very low and very high frequencies of sound in a manner similar to the response of the human ear. Therefore, the A-weighted decibel (dBA) is a good correlation to a human's subjective reaction to noise.

The following discussion sets a basis of familiarity with known and common noise levels. A quiet whisper at five feet is 20 dBA; a residential area at night is 40 dBA; a residential area during the day is 50 dBA; a large and busy department store is 60 dBA; rush hour traffic at 100 feet from the road is 60-65 dBA; a heavy truck at 50 feet is 75 dBA; and a typical construction site is 80 dBA. At the upper end of the noise spectrum, a jet takeoff at 200 feet is 120 dBA (Harris 1991).

The dBA measurement is on a logarithmic scale. The apparent increase in "loudness" doubles for every 10 dBA increase in noise (Bell 1982). Taking a baseline noise level of 50 dBA in a daytime residential area, noise of 60 dBA would be twice as loud, 70 dBA would be four times as loud, and 80 dBA would be eight times as loud.

Because of the variability of individual's reaction to noise and attitudes toward noise sources, it is impossible to accurately predict how an individual will react to a particular noise. However, when entire communities are considered, community reaction to noise may be represented with a high degree of confidence. A standard unit for measuring noise that affects communities is the Day-Night Average Sound Level (L_{dn}) that averages sound levels over a 24-hour period and adds a 10 dBA "penalty" at night from 10 p.m. to 7 a.m. to represent the intrusiveness of sound that occurs during normal sleeping hours. The L_{dn} is represented as:

$$L_{dn} = 10 * \log \{1/24 [15 * (10^{Ld/10}) + 9 * (10^{(Ln+10)/10})]\}$$

where: Ld is the average daytime noise level L_{eq} dBA.
Ln is the average nighttime noise level L_{eq} dBA.

This formulation results in adding 6.4 to the average daytime noise to obtain the L_{dn}.

Community noise can be predicted by assuming that motor vehicle traffic is the most important single contributor to the noise environment for a community not located near major highways or airports (EPA 1974). This relationship assumes the number of vehicles and types of vehicles is almost constant, and that the vehicle usage is directly proportional to population density. The L_{dn} can then be calculated using the relationship:

$$L_{dn}\ (\text{dBA}) = 10*\text{Log}\ (p) + 22$$

where: p = the population density of people with vehicles per square mile.

The Project Area has land uses that vary from sparsely populated rural areas to more densely populated small urban areas. Generally, noise levels would be about 35 dBA in rural areas away from communities and roads. In the communities, the noise should range from about 45 dBA to 52 dBA L_{dn} at locations away from the main highways and County roads in and near the communities. **Table 3–31** shows the average noise levels that can be expected based on population and size.

3.15 SOCIAL AND ECONOMIC ENVIRONMENT

The Ferron Natural Gas Project represents the second phase of a leasing program which encompasses three geographic areas centered around Price, Utah including the North and South Areas (this project) and the Central area covered in the recent Price CBM EIS (BLM 1997c). The information and analysis in this section is founded upon the information contained in the Price CBM EIS, tiering to, and building upon the previous EIS. The following paragraphs summarize relevant information contained in the Price CBM EIS while providing additional baseline information specific to this project.

3.15.1 Population

The population levels in both Carbon and Emery counties have fluctuated considerably from 1980 through the present. In 1983, the population levels peaked at 24,100 in Carbon County and 12,700 in Emery County. However, the population of both counties declined from 1984 through 1990. In 1990, Carbon County's population leveled at 20,200 residents while Emery County had 10,300 residents, equating to a 16 percent and 19 percent decline, respectively since 1983. A decline in local mining and energy industry activities was thought to be the primary cause for the fluctuation in population levels.

Since the 1990 census, both counties have experienced small increases and decreases in population, equating to small net increases in population in both counties. The Governor's Office of Planning and Budget (GOPB) estimates that 20,437 people live in Carbon County and 10,402 people live in Emery County (GOPB 1997a). Population estimates for both Carbon and Emery counties and local cities for the last seven years are presented on **Table 3–32**. **Figure 3–14** graphically presents population trends over the last seven years for Carbon County, Emery County, and two major cities within the counties. The population levels are shown to be stable with little change.

Table 3–31
Estimated Noise Levels in Towns Near Ferron Natural Gas Project

Town	Population	Size (square miles)	Population Density[1] (people with vehicles per square mile)	Noise (dBA L_{dn})
Ferron	1,629	1.93	422	48.2
Clawson	156	0.4	195	44.9
Orangeville	1,447	1.27	569	49.5
Castle Dale	1,704	1.91	446	48.5
Huntington	1,893	2.01	471	48.7
Price	8,711	4.11	1,060	52.2
Helper	2,078	1.78	583	49.7
Kenilworth	200	0.16	625	49.9

Note:
1. Population density based on assumption that half of population drives a vehicle. This considers noise in neighborhoods and residential areas and does not consider background noise from major highways.

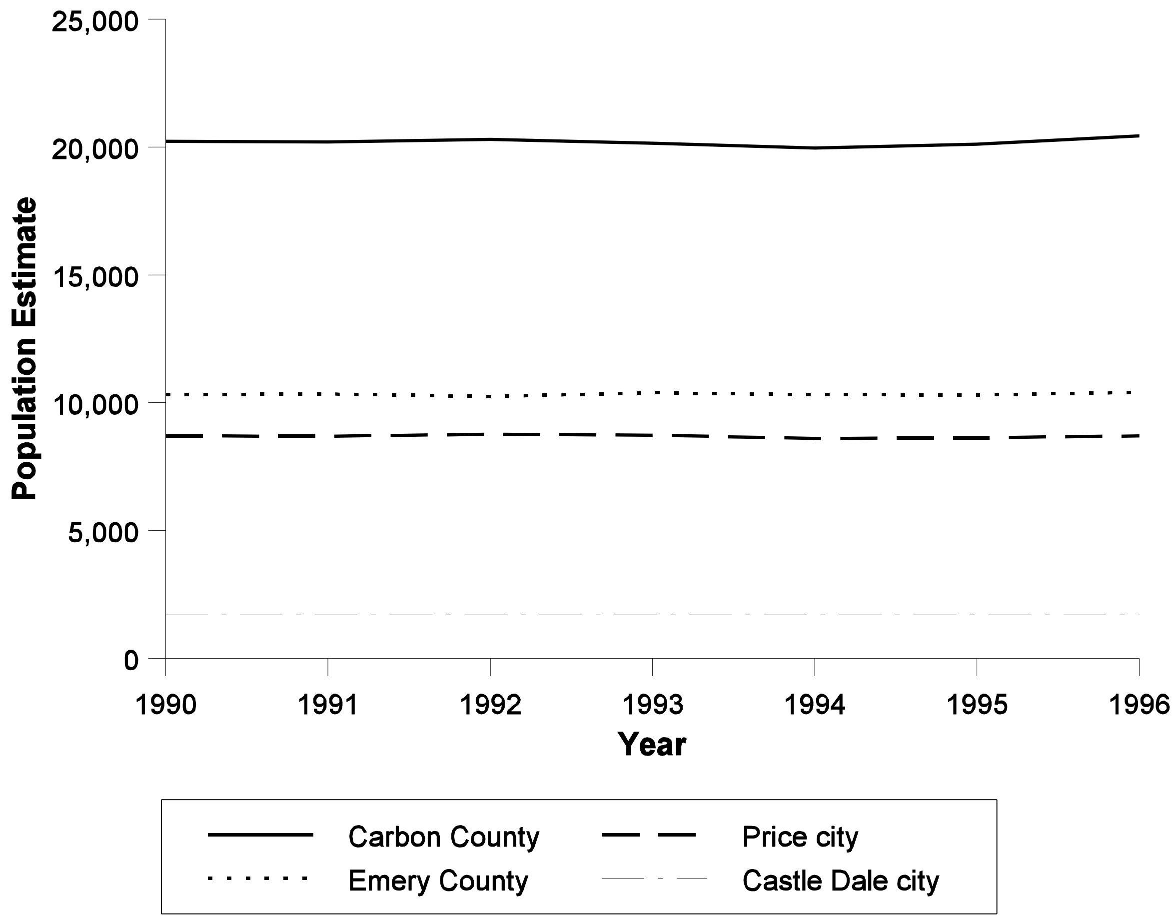


Figure 3–14 Population Estimates

Table 3–32
City Population Estimates for Carbon and Emery Counties, Utah, and U.S.A.

	1990	1991	1992	1993	1994	1995	1996	2000	2005	2010	2015	2020
Carbon County	**20,228**	**20,212**	**20,297**	**20,145**	**19,967**	**20,115**	**20,437**	**22,699**	**24,328**	**26,031**	**27536**	**28,683**
Balance of Carbon Co.	6,084	6,092	6,118	6,081	6,075	6,193	6,362					
East Carbon city	1,270	1,268	1,266	1,247	1,229	1,229	1,239					
Helper	2,148	2,135	2,128	2,091	2,061	2,057	2,078					
Price	8,712	8,699	8,764	8,726	8,610	8,626	8,711					
Scofield town	43	43	42	42	41	41	42					
Sunnyside	339	339	338	335	336	338	345					
Wellington	1,632	1,636	1,641	1,623	1,615	1,631	1,660					
Emery County	**10,332**	**10,348**	**10,247**	**10,397**	**10,318**	**10,308**	**10,402**	**11,211**	**12,060**	**12,888**	**13,140**	**13,343**
Balance of Emery Co.	1,728	1,730	1,712	1,741	1,729	1,725	1,733					
Castle Dale	1,704	1,707	1,695	1,721	1,705	1,699	1,704					
Clawson town	151	152	150	152	149	153	156					
Cleveland town	498	497	492	498	493	497	502					
Elmo town	267	274	276	286	289	298	311					
Emery town	300	299	294	298	295	294	295					
Ferron	1,606	1,606	1,588	1,613	1,599	1,599	1,629					
Green River	744	745	735	744	737	731	732					
Huntington	1,875	1,874	1,856	1,879	1,875	1,873	1,893					
Orangeville	1,459	1,464	1,448	1,465	1,447	1,439	1,447					
Utah	1,722,850	1,767,139	1,811,673	1,860,807	1,909,521	1,958,313	2,000,494	2,207,000	2,411,000	2,520,000	2,670,000	2,775,000
USA	249,398,000	252,124,000	255,002,000	257,795,000	260,295,000	262,890,000	265,284,000	274,634,000	285,981,000	297,716,000	310,134,000	322,742,000

Source: GOPB 1997a, U.S. Bureau of the Census 1996, Utah Foundation 1997

For comparison purposes, recent (last 6 years) population estimates and growth rates for Carbon and Emery Counties, as well as the State of Utah and the United States are provided in **Table 3–32.** Approximately 43 percent of Carbon County's total population resides in the city of Price (the county seat), while only 16 percent of Emery County's total population resides in its county seat, Castle Dale. Carbon and Emery counties' populations make up only 1 and 0.5 percent, respectively, of the total population in the state of Utah. The rate of growth for Carbon and Emery counties are well below the state and national averages. These comparisons are also presented graphically on **Figure 3–15**. During the 1990s, Carbon County's population has increased at an average annual rate of 0.84 percent, the fifth lowest rate in the State of Utah. During the same period, Emery County's population increased at an average annual rate of 0.69 percent. The reader should note that the GOPB population estimates are somewhat higher than official Census estimates.

In 1996, Price, the Carbon County seat and largest city in the County, had an estimated population of 8,711. Additionally, Carbon County's average household size of 2.8 people is among the lowest in the state. The median age in Carbon County is 29 years. This is older than the State average of 25.9 years (GOPB 1997b). The GOPB projects the population of Carbon County to rise to 28,683 by the year 2020 as indicated on **Table 3–32**. In addition to the cities listed on the table, Kenilworth, a small residential community located north east of Price, is located within the Project Area. It is estimated that approximate 200 persons reside in this former mining company town.

As of 1996, the population of Castle Dale, the Emery County seat, was 1,704 people. Huntington, Emery County's largest city, had a population of about 1,893 (1996). Emery County's average household size of 3.2 people is the forth largest in the State of Utah. Its median age of 25.2 is slightly younger than the state average of 25.9. The GOPB projects the population of Emery County to reach 13,343 by the year 2020. Population projections for both Carbon and Emery Counties through the year 2020 are presented in **Table 3–32** and shown graphically in **Figure 3–16.**

The GOPB 1996 data describes the Carbon County population as approximately 49 percent male and 51 percent female, and a median age of 29 years. The Emery County population is given as 51 percent male and 49 percent female, and a median age of 25 years. A breakdown of the percentage of total population by selected age groups for Carbon and Emery Counties is shown in **Table 3–33**.

Table 3–33
Percentage of Total Population by Selected Age Groups, 1995

Age Group	Carbon County (percent)	Emery County (percent)
0–4 years	8	7.8
5–17 years	23.9	30.3
18–29 years	17.8	15.2
30–39 years	13.1	13.9
40–64 years	23.8	24.4
65+ years	13.4	8.4

Source: GOPB 1997b

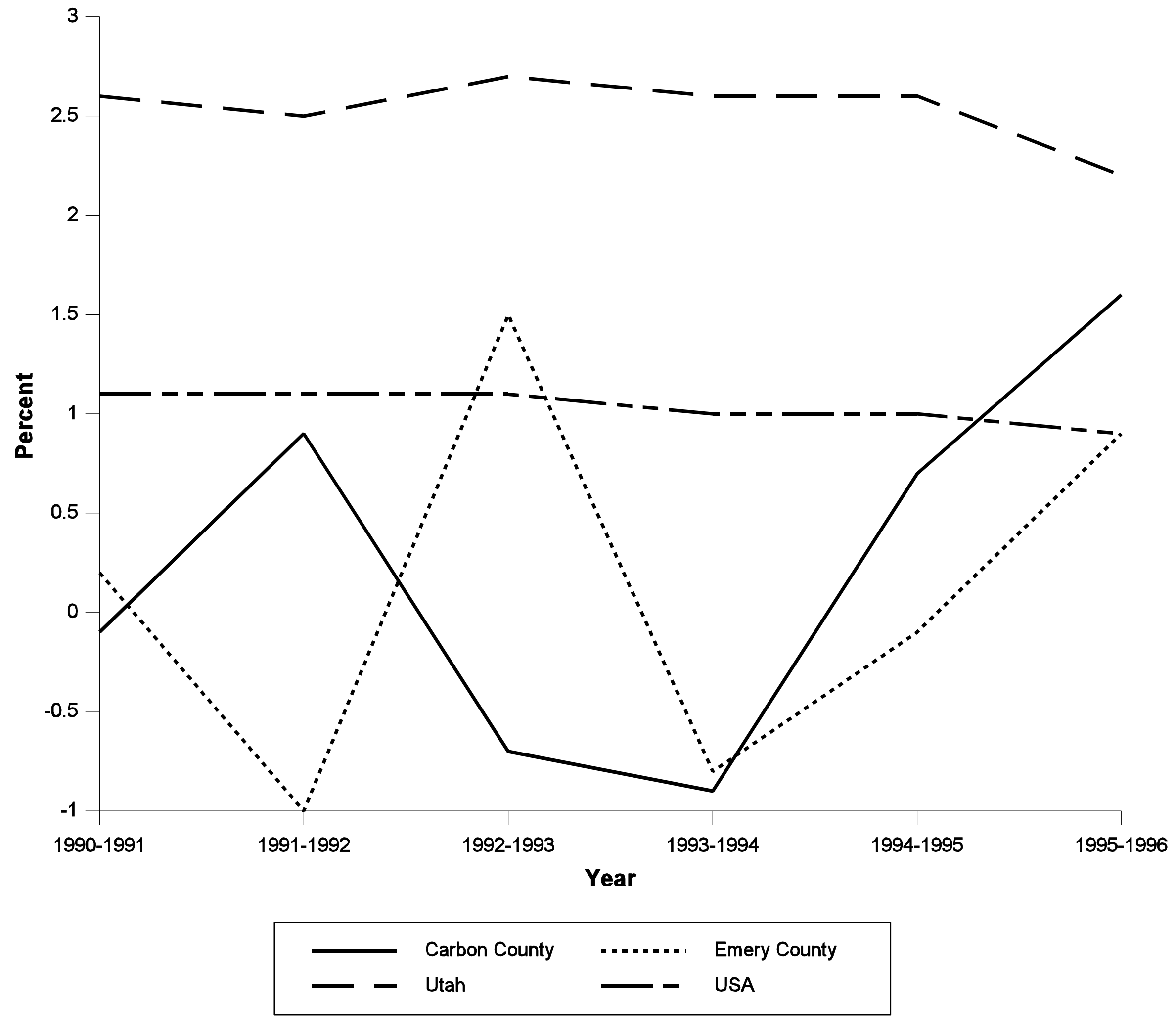


Figure 3–15 Population Growth

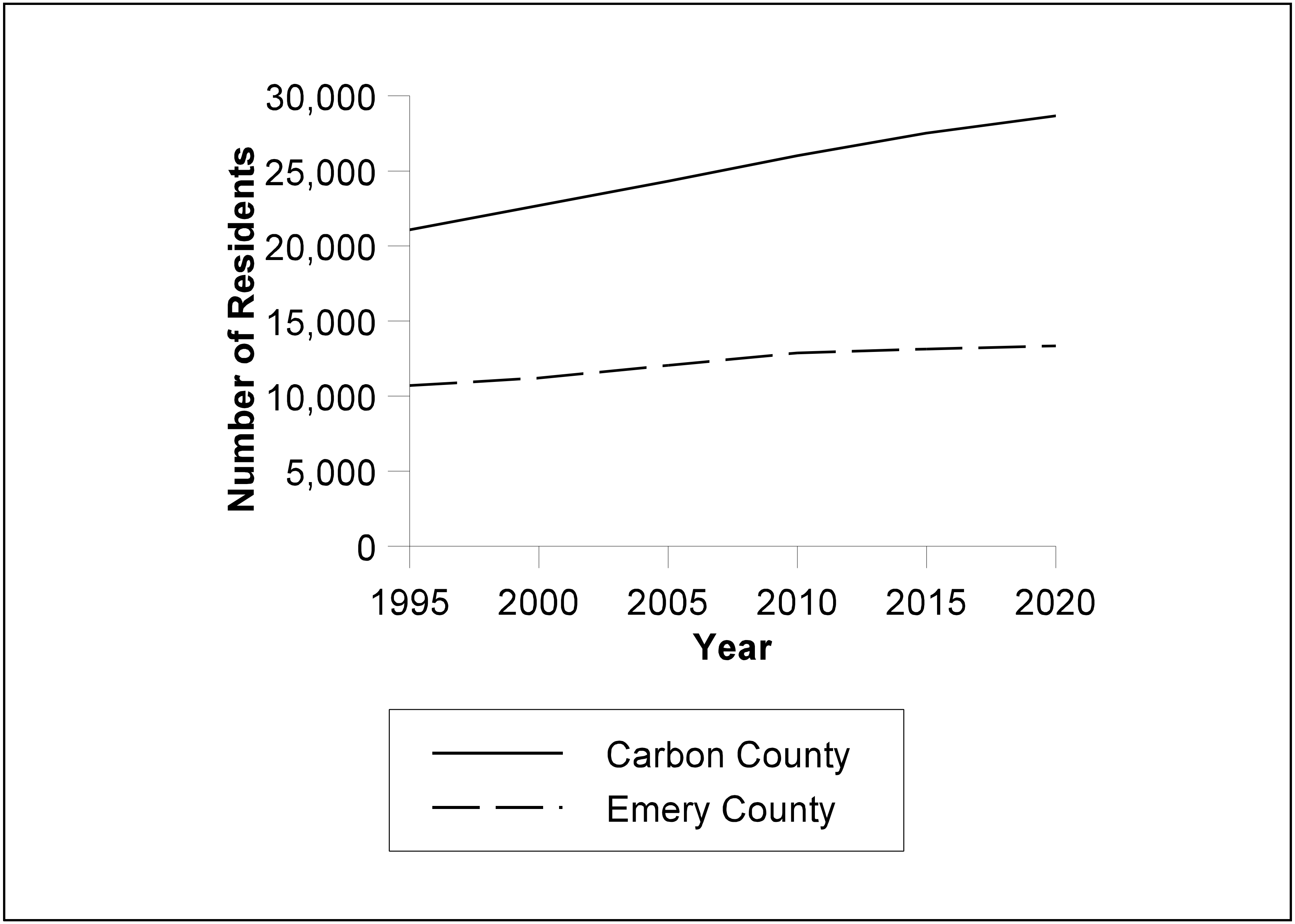


Figure 3–16 Population Projections

The racial composition of Emery and Carbon Counties, compared with the state of Utah is shown on **Table 3–34**. The majority of the population (96 percent) in Emery County is white, with smaller percentages of black, American Indian, and persons of Hispanic dissent comprise the balance of the population. Carbon County's racial composition is somewhat more diverse, with white persons accounting for about 88 percent of the total population in 1994.

The Church of Latter Day Saints (LDS) membership has dropped in Emery County from 8,403 in 1991 to 5,877 in 1996. The LDS membership in Carbon County rose slightly in the same period from 10,196 to 10,245 members. During this period from 1991 to 1996, LDS membership in Utah increased from 1,236,244 to 1,398,170 (LDS 1996).

3.15.2 Local Economy, Employment, and Wages

The economies of Carbon and Emery County are different in composition. Emery County's retail trade and service sectors are relatively small while mining and utilities comprise a more significant employment sector. Generally, the opposite is true in Carbon County with a substantial percentage of employment in government, trade and services. In recent years, employment opportunities in Carbon County have steadily increased. By the third quarter of 1994, employment in Carbon County increased by about 2.8 percent. Recent growth has been steady in nearly all employment sectors except the mining industry. The manufacturing, service, and retail trade employment sectors experienced the strongest growth. The majority of commercial activity is centered in Price located in Carbon County. Commercial business activity has been strong in Price in recent years. There is also relatively minor commercial business activity in towns within Emery County, however in general terms, Emery County has experienced more modest growth in the service and retail sectors (BLM, 1997a).

Currently, the government, trade, services, and mining industries comprise over 70 percent of Carbon County's total employment. Since 1980, the services and manufacturing industries have grown the fastest, while mining has lost the greatest percentage of jobs. The Carbon County School District, Castleview Hospital (medical services), The City of Price (local government), Utah Power and Light, Utah Fuel Company, and Cyprus Plateau (coal mining), and Koret of California (textile manufacturing) are among the largest employers in Carbon County. Current and projected employment distribution by industry for Carbon County is shown on **Table 3–35**. Employment distribution percentages are shown graphically on **Figure 3–17**.

In Emery County, Energy West (coal mining) is Emery County's largest employer. The Emery County School District, the Castledale and Huntington units of Utah Power and Light (electric utility) the County local government, and Genwal Resources (mining) are also major employers. Historical and projected employment distribution for Emery County is shown on **Table 3–36**. Emery County's employment distribution is shown graphically on **Figure 3–18**.

Local economic trends in Carbon and Emery Counties have been described previously in the Price CBM EIS. In summary, the economy of these two counties has historically been founded on resource extraction, and have been subject to changes in the coal mining and energy markets which have had a substantial effect on the local economy and employment. Throughout the late 1970s and early 1980s when the energy market was relatively strong, the economy and employment opportunities in Carbon and Emery Counties grew steadily. Beginning in 1982, the national recession coupled with the declining energy market and mechanized coal mining resulted in a substantial reduction in employment and increased unemployment.

Table 3–34
Racial Composition By County and State, 1980 and 1994

	Total Population		Percent White		Percent Black		Percent American Indian, Eskimo, or Aleut		Percent Asian or Pacific Islander		Percent Hispanic Origin	
Area	**1980**	**1994**	**1980**	**1994**	**1980**	**1994**	**1980**	**1994**	**1980**	**1994**	**1980**	**1994**
Carbon Co.	22,179	21,099	0.88	0.88	0.00	0.00	0.01	0.01	0.01	0.01	0.11	0.10
Emery Co.	11,451	10,600	0.96	0.96	0.00	0.00	0.01	0.00	0.00	0.00	0.02	0.03
Utah State	1,461,037	1,915,988	0.93	0.93	0.01	0.01	0.01	0.01	0.03	0.02	0.04	0.06

Table 3–35
Historical and Projected Employment by Industry — Carbon County

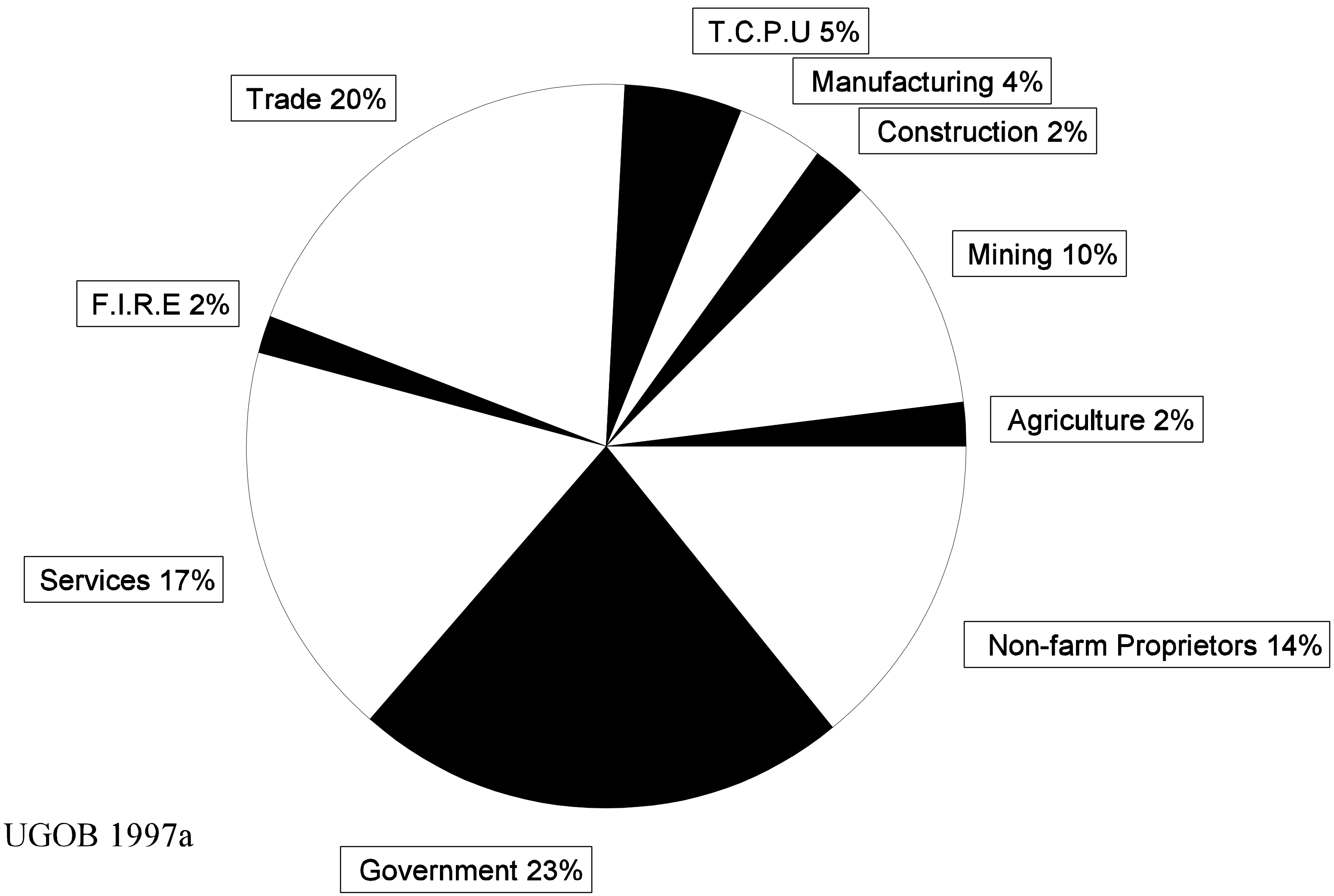
Industry	1990 Number Employed	1990 Portion of Total Employment (percent)	1995 Number Employed	1995 Portion of Total Employment (percent)	2000 Number Employed	2000 Portion of Total Employment (percent)	2005 Number Employed	2005 Portion of Total Employment (percent)
Agriculture	240	2.62	236	2.42	241	202	235	1.96
Mining	1,349	14.86	1,000	10.25	1,223	11.17	1,397	11.67
Construction	142	1.55	241	2.47	301	2.75	358	2.99
Manufacturing	288	3.15	393	4.03	539	4.92	619	5.17
T.C.P.U.[1]	467	5.11	489	5.01	535	4.89	573	4.79
Trade	1,764	19.29	1,957	20.06	2,129	19.44	2,244	18.75
F.I.R.E.[2]	164	1.79	176	1.80	191	1.74	202	1.69
Services	1,459	15.96	1,692	17.34	1,989	18.17	2,237	18.69
Government	2,201	22.10	2,207	22.62	2,319	21.18	2,516	21.02
Non-farm Proprietors	1,240	13.56	1,367	14.01	1,482	13.54	1,588	13.27
Total	9,144	100.00	9,758	100.00	10,949	100.00	11,969	100.00

Notes:
1. T.C.P.U. = Transportation, Communication, and Public Utilities
2. F.I.R.E. = Finance, Insurance, and Real Estate
Source: GOPB 1997b

Table 3–36
Historical and Projected Employment by Industry — Emery County

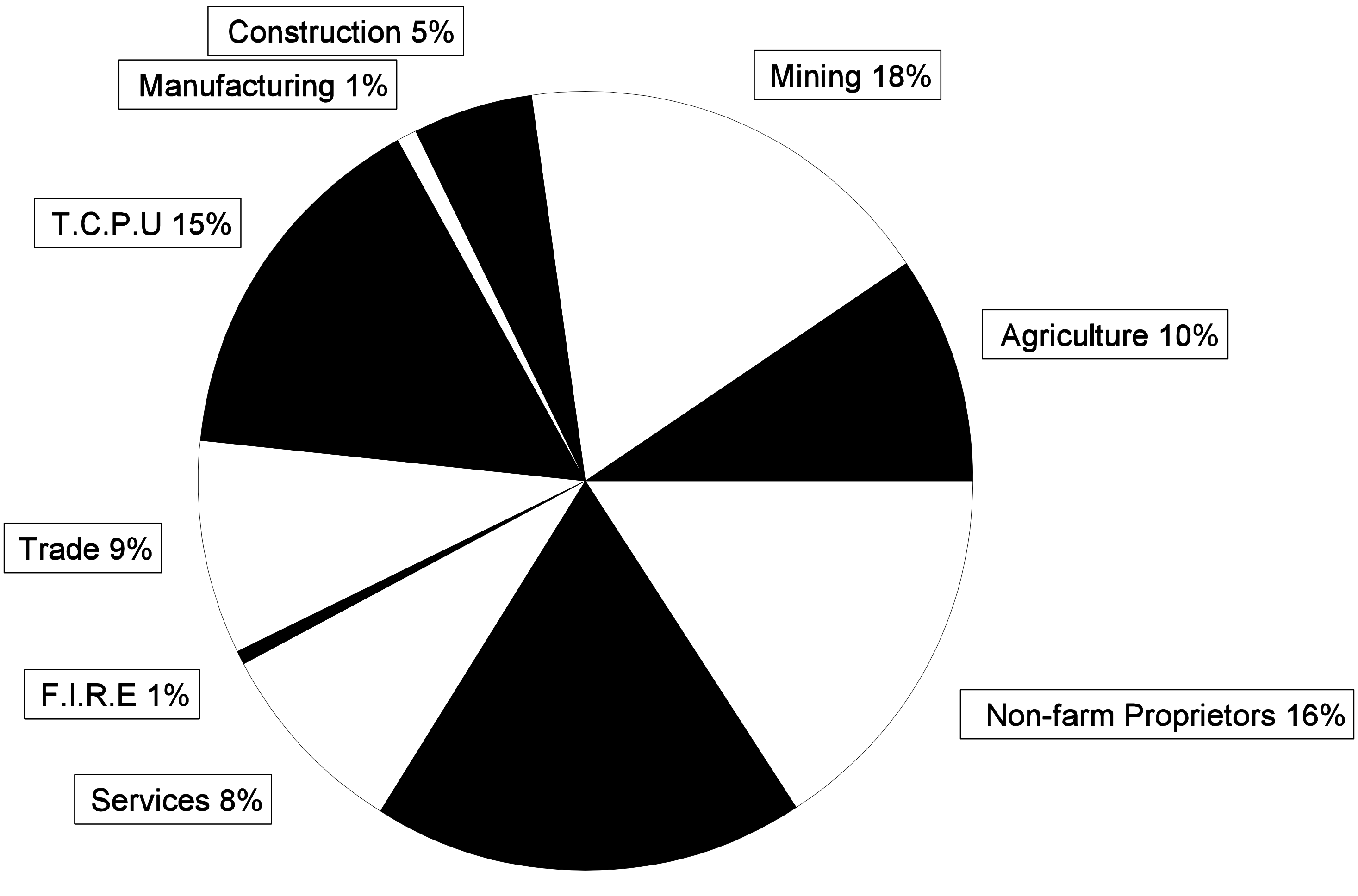
Industry	1990 Number Employed	1990 Portion of Total Employment (percent)	1995 Number Employed	1995 Portion of Total Employment (percent)	2000 Number Employed	2000 Portion of Total Employment (percent)	2005 Number Employed	2005 Portion of Total Employment (percent)
Agriculture	500	10.25	491	9.91	502	9.29	489	8.23
Mining	1,002	20.55	867	17.5	980	18.13	1,158	19.49
Construction	267	5.47	250	5.05	383	7.08	560	9.43
Manufacturing	13	0.27	40	0.81	98	1.81	133	2.24
T.C.P.U.[1]	766	15.71	757	15.28	773	14.3	781	13.15
Trade	437	8.96	423	8.54	448	8.29	465	7.83
F.I.R.E.[2]	42	0.86	42	0.85	45	0.83	47	0.79
Services	286	5.86	405	8.18	475	8.79	537	9.04
Government	819	16.79	894	18.05	875	16.19	898	15.12
Non-farm Proprietors	745	15.28	784	15.83	827	15.3	873	14.69
Total	4,877	100.00	4,953	100.00	5,406	100.00	5,941	100.00

Notes:
1. T.C.P.U. = Transporation, Communication, and Public Utilities
2. F.I.R.E. = Finance, Insurance, and Real Estate
Source: GOPB 1997b



Source: UGOB 1997a

Figure 3–17 Carbon County Employment by Industry



Source: UGOPB 1997a

Figure 3–18 Emery County Employment by Industry

Statewide employment distribution is provided on **Table 3–37**, and shown on **Figure 3–19**. Compared to Carbon County, the mining industry provides a larger percentage of employment (17 percent), while the trade sector (9 percent) and government sector (18 percent) make up a smaller percentage of total employment in the county. Agriculture provides a larger percentage of employment in Emery County (10 percent). A relative comparison of employment by sector for each county is shown on **Figure 3–20**.

The distribution of labor income among major industries provides some insight into the structure of a local economy. As shown in **Table 3–38**, the average annual wages in the mining industry both statewide and in Carbon and Emery Counties are significantly higher than many other industries. In addition, the mining industry accounted for about 27 percent of total labor income in Carbon County and 36 percent of the total in Emery County in 1995. Mining wages are also higher on average in Carbon and Emery Counties than the statewide average.

In general, **Table 3–38** shows that the average wages for all other industries are lower in Carbon and Emery Counties than the statewide average. Statewide, labor income in the mining industry accounts for only 1.6 percent of the total. In Emery County, about 33 percent of labor income is distributed to the transportation, communication, and utilities sector. Approximately 26 percent of labor income in Carbon County falls within the services category, accounting for regional retail activity occurring primarily in Price. **Table 3–39** shows that the Carbon and Emery County contribution to the statewide payroll is very small, except for the mining payrolls, accounting for 14 and 11 percent, respectively.

Per capita income in Carbon County is lower than both the Utah and national average as shown on **Figure 3–21** and **Table 3–40**. In Emery County the average annual wage is higher than both the state and national average.

3.15.3 Housing

A housing inventory for 1994 limited to the major communities within the central study area identifies about 6,700 total units in Carbon County and includes single family homes, duplexes, apartments and mobile homes. About 75 percent of these units are single family dwellings. At the time of this inventory, vacancy rates ranged between 0-6 percent within the study area. For Emery County, the inventory found 2,094 units of all types, with vacancy rates between 0-14 percent. Approximately 70 percent of these units are single family dwellings.

According to the Southeastern Utah Association of Local Governments (SUALG), there were approximately 8,364 housing units in Carbon County in 1996. The same source indicates that Emery County had 3,557 total housing units. Unfortunately, housing inventory information for the study area is fairly limited and inconsistent. Construction reports issued by the Bureau of Economic and Business Research (BEBR) indicate that about 646 building permits were issued in Carbon County in 1996, while 206 were issued in Emery County. These reports conclude that of the permits issued, a total of about 93 dwelling units were constructed in Carbon County, of which 28 percent were single family units. In Emery County, the BEBR reports a total of 15 units constructed in 1996, of which 53 percent were single family.

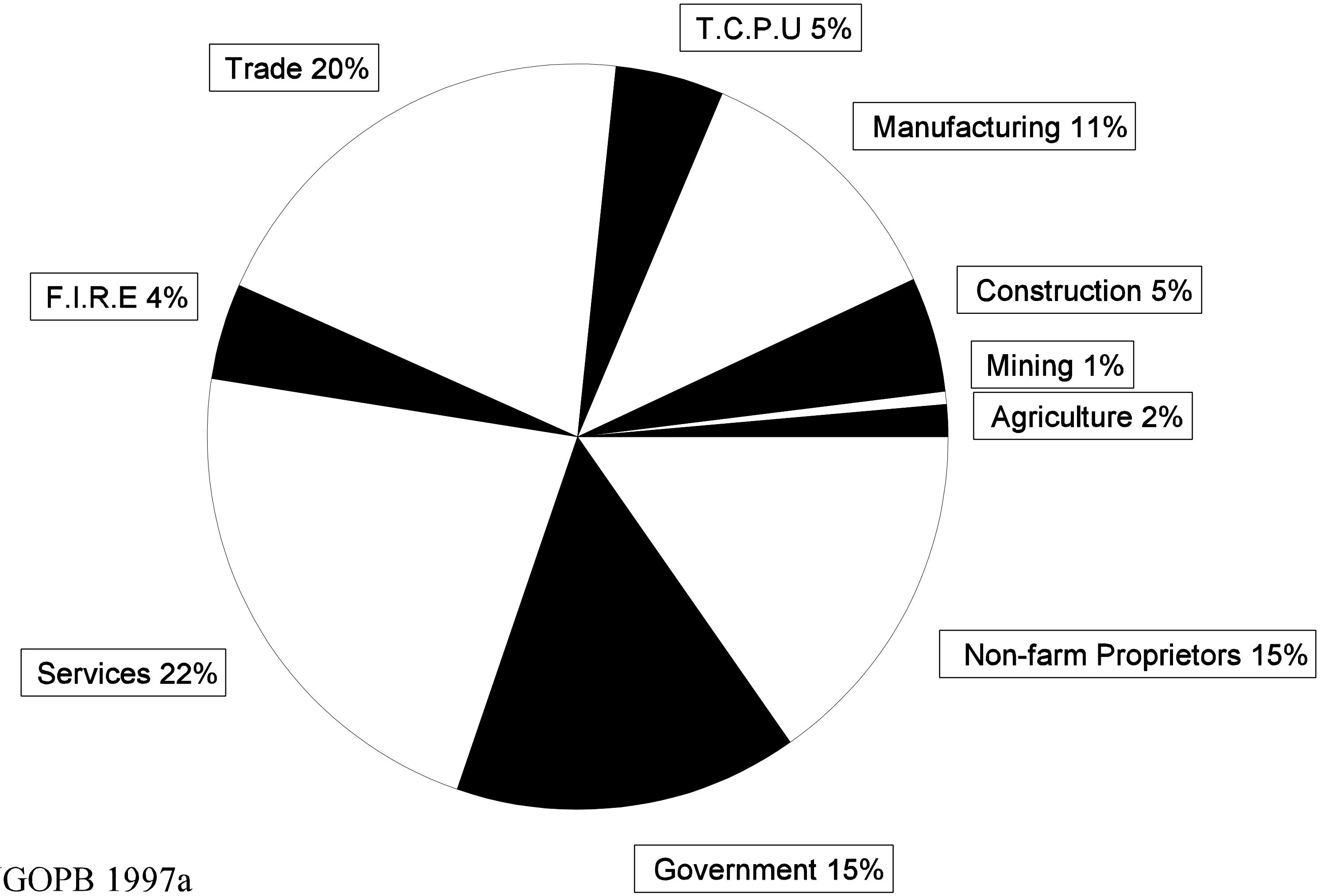
The Utah Association of Realtors reported 178 home sales in Carbon and Emery County in 1995, and 188 in 1996. The average value in 1996 was about $72,000, up from an average of $60,898 in 1995.

Table 3–37
Historical and Projected Employment by Industry — State of Utah

Industry	1990 Number Employed	1990 Portion of Total Employment (percent)	1995 Number Employed	1995 Portion of Total Employment (percent)	2000 Number Employed	2000 Portion of Total Employment (percent)	2005 Number Employed	2005 Portion of Total Employment (percent)
Agriculture	18,918	2.13	18,690	1.70	19,991	1.54	19,549	1.34
Mining	8,603	0.97	8,114	1.74	8,616	0.67	8,903	0.61
Construction	27,926	3.14	54,793	4.98	64,267	4.96	65,505	4.50
Manufacturing	107,100	12.04	123,867	11.26	144,504	11.15	152,448	10.48
T.C.P.U.[1]	42,283	4.75	51,493	4.68	61,179	4.72	63,319	4.35
Trade	172,399	19.38	220,025	20.00	259,364	20.02	293,519	20.19
F.I.R.E.[2]	34,134	3.84	47,678	4.33	55,759	4.30	62,238	4.28
Services	185,896	20.90	244,054	22.18	302,873	23.38	355,550	24.45
Government	150,556	16.92	163,666	14.88	179,098	13.82	200,937	13.82
Non-farm Proprietors	141,766	15.94	167,839	15.22	199,889	15.43	232,134	15.96
Total	889,581	100.00	1,100,219	100.00	1,295,540	100.00	1,454,102	100.00

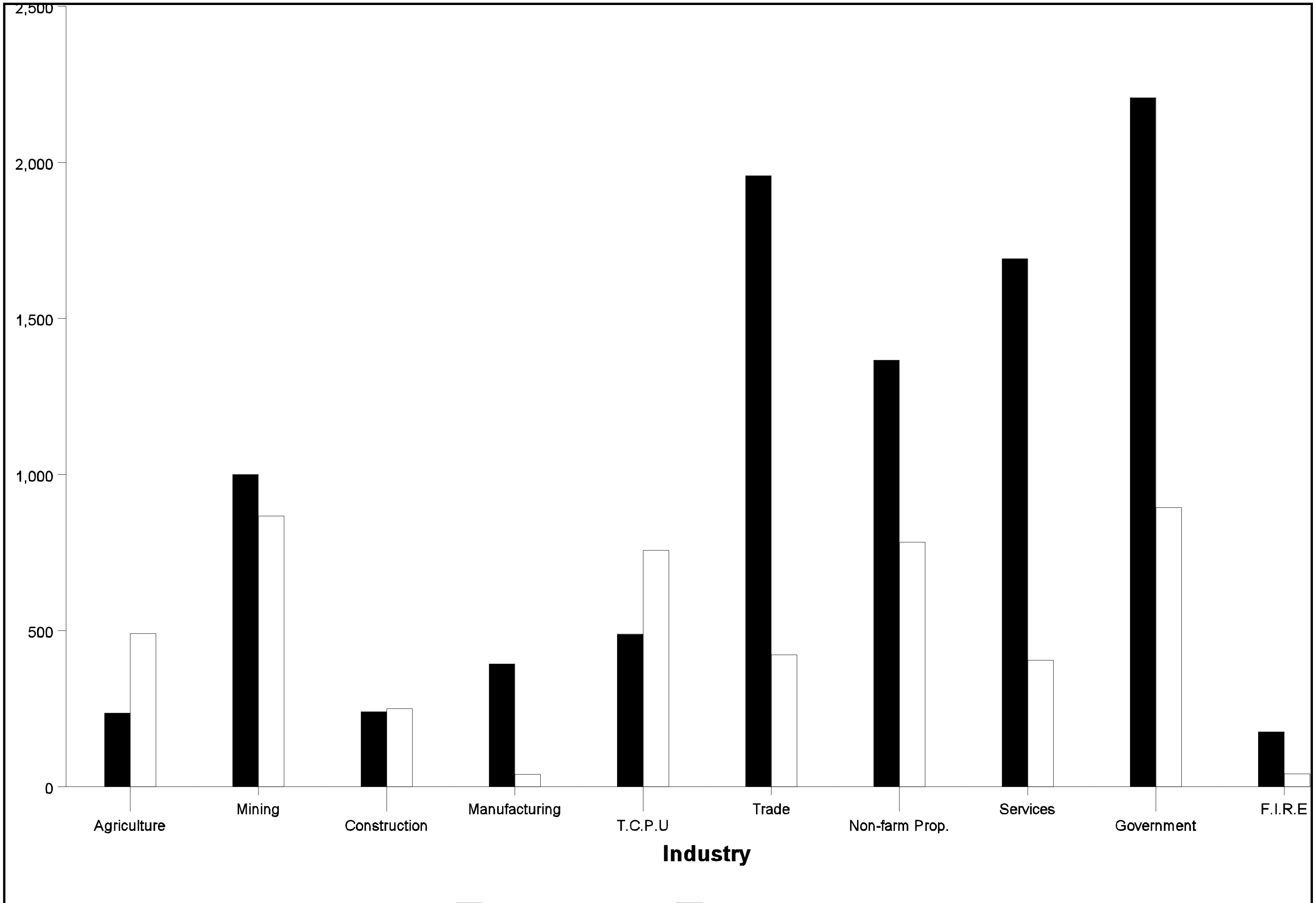
Notes:
1. T.C.P.U. = Transporation, Communication, and Public Utilities
2. F.I.R.E. = Finance, Insurance, and Real Estate

Source: GOPB 1997b



Source: UGOPB 1997a

Figure 3–19 Utah Employment by Industry



Source: UGOPB 1997a

Figure 3–20 Employment by Industry — 1995

Table 3–38
Labor Income by Industry, 1995
Average Annual Wage and Annual Payroll

Industry	Utah		Carbon County		Emery County	
	Average Annual Wage ($)	Annual Payroll (million $)	Average Annual Wage ($)	Annual Payroll (million $)	Average Annual Wage ($)	Annual Payroll (million $)
Construction	24,500	1342.9	22,600	5.4	24,300	6.1
Finance, Insurance, Real Estate	27,600	1328.2	18,200	3.3	13,800	0.6
Manufacturing	28,600	3545.2	20,000	7.8	18,600	0.7
Mining	41,800	339.6	48,000	48.0	44,400	38.5
Public Administration (Government)	28,900	1851.6	21,700	19.9	20,900	7
Trade - Retail	13,400	2344.9	10,500	16.1	7,600	3.1
Trade - Wholesale	29,900	1368.4	28,100	11.9	26,000	0.5
Services & Misc.	21,500	6987.7	16,300	46.5	17,500	15.4
Transportation, Communication & Utilities	32,000	1912.7	34,400	20.1	42,800	35.4
Total	23,200	21118.0	22,000	179.3	29,200	107.4

Source: Utah Department of Community and Economic Development 1997

Table 3–39
1995 Annual Payroll by Industry by State and County

	Utah	Carbon County		Emery County	
Industry	**Annual Payroll (million $)**	**Annual Payroll (million $)**	**Portion of Utah State Payroll (percent)**	**Annual Payroll (million $)**	**Portion of Utah State Payroll (percent)**
Construction	1,342.9	5.4	0.4	6.1	0.5
Finance, Insurance, Real Estate	1,328.2	3.3	0.2	0.6	<0.1
Manufacturing	3,545.2	7.8	0.2	0.7	<0.1
Mining	339.6	48.0	14.1	38.5	11.3
Public Administration (Government)	1,851.6	19.9	1.1	7.0	0.4
Trade - Retail	2,344.9	16.1	0.7	3.1	0.1
Trade - Wholesale	1,368.4	11.9	0.9	0.5	<0.1
Services & Misc.	6,987.7	46.5	0.7	15.4	0.2
Transportation, Communication & Utilities	1,912.7	20.1	1.1	35.4	1.9
Total	21,118.0	179.3	0.8	107.4	0.5

Source: Utah Department of Community and Economic Development 1997

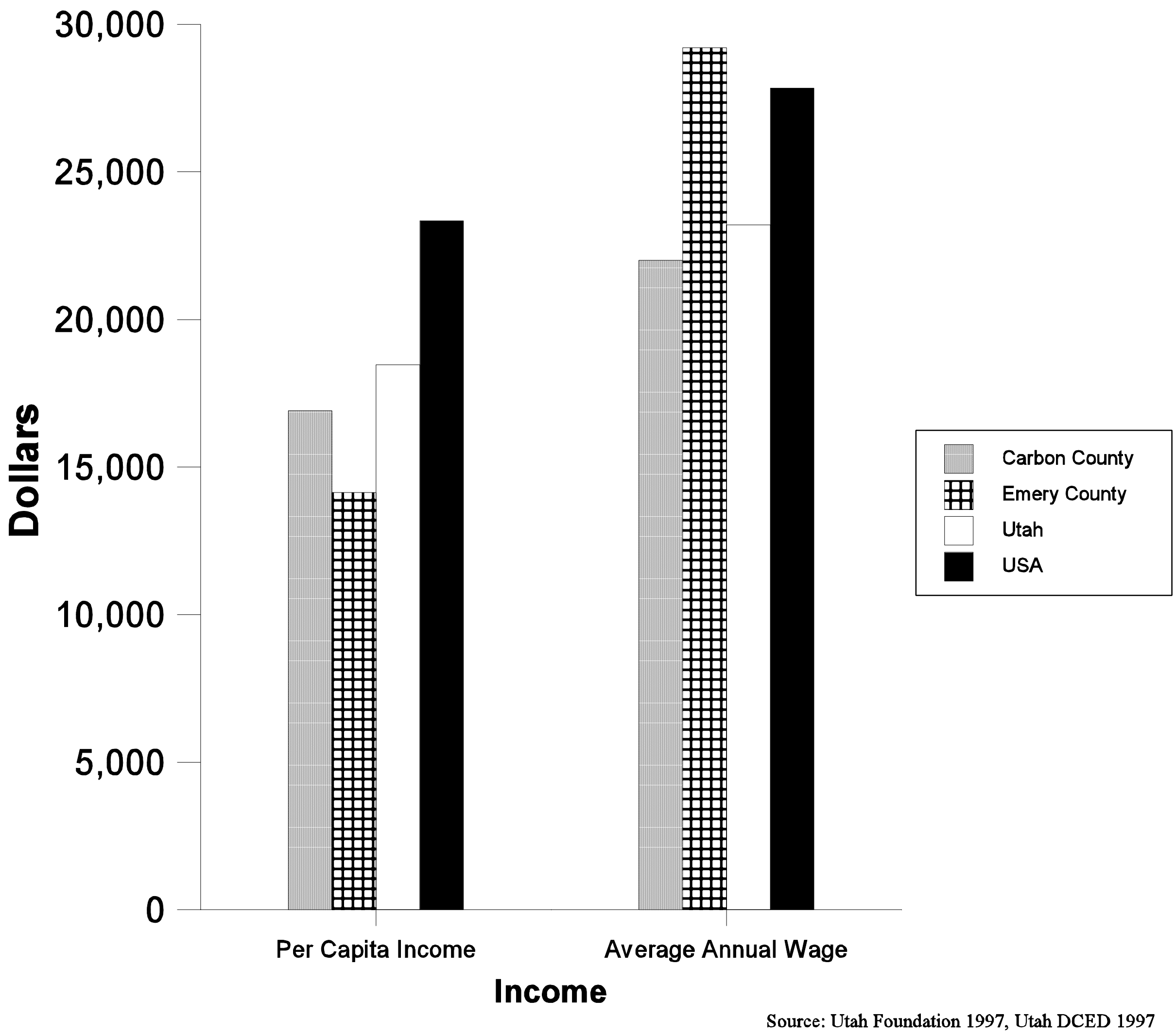


Figure 3–21 Per Capita Income and Average Income, 1995

Table 3–40
Per Capita Personal Income and Average Annual Wage, 1995

Location	Per Capita Personal Income ($)[1]	Average Annual Wage ($)[2]
Carbon County	16,909	22,000
Emery County	14,134	29,200
Utah	18,468	23,200
USA	23,345	27,846

Sources: Utah Foundation 1997, Utah Department of Community and Economic Development 1997

There is an abundance of temporary housing accommodations in the study area, which would be available to project contractors. Numerous mobile homes parks, motels, and campgrounds are present. In 1994, there were 570 motel rooms in Price, Wellington, and Helper. Five mobile home parks with a capacity of 30 spaces are located in Carbon County. Only a modest number of temporary accommodations are available in Emery County.

3.15.4 Community Facilities and Services

Natural gas exploration and resource development activities have the potential to effect existing community facilities and infrastructure. The use of, or connection to, existing infrastructure including roads with project activities may affect service agencies capacity or conveyance systems, or may require the installation of new facilities. In addition, natural gas activities in the two-county area may also impact employment and population, which subsequently can effect local community services such as schools, law enforcement, or medical facilities. The following paragraphs present a baseline description of these facilities and services as the pertain to project activities.

3.15.4.1 Roads, Water and Wastewater Systems, and Solid Waste Disposal

Federal and State highways, county roads, and roads and trails on federal lands would be utilized for the movement of equipment required for gas exploration and development activities. The North Area lies just to the east of U.S. Highway 6. The northwest corner of the North Area is accessed via road 157 south of the City of Helper. Several other local roads and trails extending north and northwest of the City of Price allow access to the North Area.

The South Area is bordered by U.S. Highway 10. In the north portion of the South Area, road 31 extends northwest from the city of Huntington. The center of the South Area is accessed via road 29 and 57 near the cities of Castle Dale and Orangeville. Various other local roads and jeep and pack trails are found throughout the South Area. Construction and maintenance of these roads is accomplished by a variety of entities.

Domestic water is provided to various communities within Carbon County by the PRWID and several local water districts. The PRWID provides all domestic water to the City of Wellington and unincorporated communities within the County, such as Spring Glen and Carbonville. The cities of Price and Helper have their own water systems, which is occasionally supplemented with water from the PRWID. The PRWID's water treatment plant has recently been expanded and currently has capacity to treat 6 million gallons per day (Mgd). PRWID also provides wastewater treatment services for all of Carbon county. Typical flows at the plant are in the range of 2.1 to 2.2 Mgd.

In Emery County, water and wastewater treatment services are provided by the Castle Valley Special Service District, which is currently operating below capacity.

3.15.4.2 Public Schools, Law Enforcement and Fire Protection, and Medical Facilities

In Carbon County, there are four elementary schools, three secondary/junior high schools, and one high school. In the Fall of 1997, enrollment in these schools was about 4,771, increasing by about 6.1 percent from the previous year. However, over a five year period between 1991 and 1995, enrollment was down about four percent in the Carbon County district. The Price CBM EIS reported that each of the schools in the district is generally nearing or currently at capacity levels; however, after a four-year trend of declining enrollments, some additional capacity may be available. In Emery County, there are four elementary schools, one secondary school, and one high school. Total enrollment the fall of 1997 in the schools was about 3,228, representing a decline from the previous year of about 2.6 percent. Each of these schools except for Canyon View Secondary School and Emery County High School has capacity for additional students. Similar to Carbon County, enrollment in the district has generally shown small decreases annually for the last five years. (Utah State Office of Education 1997)

Established in 1937, the College of Eastern Utah (CEU) provides higher education to the region. CEU is located in Price and includes a campus of 15 buildings. Student enrollment is more than 3,000. CEU offers associate degree programs, vocational-technical programs, developmental programs, and other adult programs that are transferable to four year universities.

Law enforcement services within unincorporated Carbon County are provided by the Carbon County Sheriff's Department and the Utah Highway Patrol. The Carbon County Sheriff's Department maintain 15 sworn officers (Robertson 1998). The cities of Price, Helper, and Wellington maintain their own police departments. Fire protection is provided by the City of Price or local volunteer fire departments in Helper and Wellington. The Emery County Sheriff's Department and the Utah Highway Patrol provide law enforcement services to all areas of Emery County. The Sheriff's Department maintains 26 sworn officers (Jensen 1998). The Highway Patrol generally maintains six patrol vehicles in the county. Fire protection services are provided by the Special Service District, staffed by approximately 87 volunteer firemen, equipped with 30 fire trucks. **Table 3–41** provides the number of reported criminal offenses occurring in Carbon and Emery counties in 1996.

Castleview Hospital in Price is the largest medical facility in the Project Area. This is a full service hospital providing 24-hour emergency service, specialized physicians, ground and air transportation services. Several other clinics, nursing homes and the Southeastern Utah Health Department are provide medical services in both Carbon and Emery counties.

3.15.5 Public Finance

Utah state mineral lease royalties are collected for gas wells located on state lands. Royalty payments are based on the volume of gas produced. Depending on the type of lands, royalties are either deposited into the

Table 3–41
Number of Offenses Reported — 1996

Type of Offense	Emery County[1]	Carbon County[2]
Drug/Narcotics	76	161
Destruction/Vandalism	178	356
Murder	0	1
Sexual Offenses (Rape)	0	30
Robbery	1	2
Aggravated Assault	11	245
Stolen Property Violation	38	12
Fraud	1	7
Burglary	84	103
Counterfeit/Forgery	10	26
Larceny/Theft	428	589
Motor Vehicle Violation	5,223	40
Arson	1	14
Kidnaping	2	5
Extortion/Blackmail	0	2
Gambling	0	0
Pornography	2	0
Prostitution	0	2
Weapon Law Violation	22	140
Total	6,077	1,735

Source: Jensen 1998, Robertson1998

state's school trust or the general fund. Federal mineral lease royalties are collected for gas wells located on public lands based on the volume of gas produced. Fifty percent of this revenue is returned to the State. The state allocates one third of the revenue collected from gas royalties to the Permanent Community Impact Fund which is available to cities within Carbon and Emery counties to obtain funding for infrastructure related projects. Another 25 percent of the revenue is allocated back to the county from which the natural gas originated.

Within the Project Area, the local share of federal mineral royalties is paid to the Carbon and Emery County Road Special Service Districts to cover the cost of road maintenance and improvements.

Ad valorem tax is levied by Carbon and Emery Counties on facilities and/or improvements constructed by companies. Sales and use tax is also collected on purchases of materials and supplies including gravel, pipe, and motor fuel. Transient occupancy and restaurant taxes are collected from lodging facilities and restaurants.

3.15.6 Quality of Life

Quality of life is a subjective measure of an individuals happiness with a particular geographic location based on a composition of self-defined variables. These variables typically vary by geographic region and can include both rural and urban components. Frequently, measures of a particular "quality of life" include traffic conditions and congestion levels, parks and recreational opportunities, affordability of housing and/or commercial facilities, climate, employment opportunities, the quality of regional air and water, and many others.

Previous studies within the Carbon and Emery County region (BLM 1997c) have indicated a quality of life perception which includes the abundance of open space, wildlife hunting and viewing, a substantial network of roads and trails supporting activities such as mountain biking, hiking, horseback riding, and off-road vehicle use.

Current traffic and transportation conditions are described in **Section 3.10**. Existing air quality and noise conditions are discussed in **Sections 3.3** and **3.14**. Other quality of life factors, such as crime and community values and religion, are not anticipated to be impacted by the proposed project and therefore are not detailed in this report. Furthermore, prediction of how these parameters would be affected by project implementation over the lifespan of the project would be nearly impossible to predict.

3.15.6.1 Tourism

Recently, tourism has become a more important part of the economy in Carbon and Emery counties. As described in **Section 3.12**, there are a variety of tourist attractions and recreational opportunities available within the two-county region. Ninemile Canyon, the San Rafael Swell, and the use of public lands for hunting, off-road vehicles, wildlife observation, Indian Rock art viewing, hiking, and mountain biking are some of the recreational activities offered in the region. Price is generally thought to be the central hub for accommodations and goods and services from which visitors can disburse throughout the counties. Tourism in the region contributes to a diversified economy and quality of life as perceived by residents.